

GENERAL INFORMATION

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46

Current Science

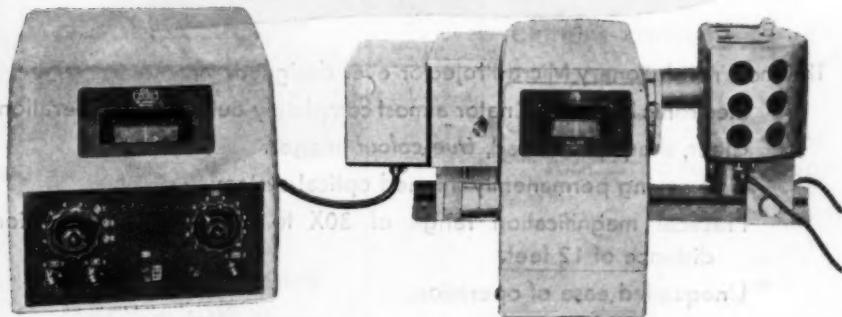
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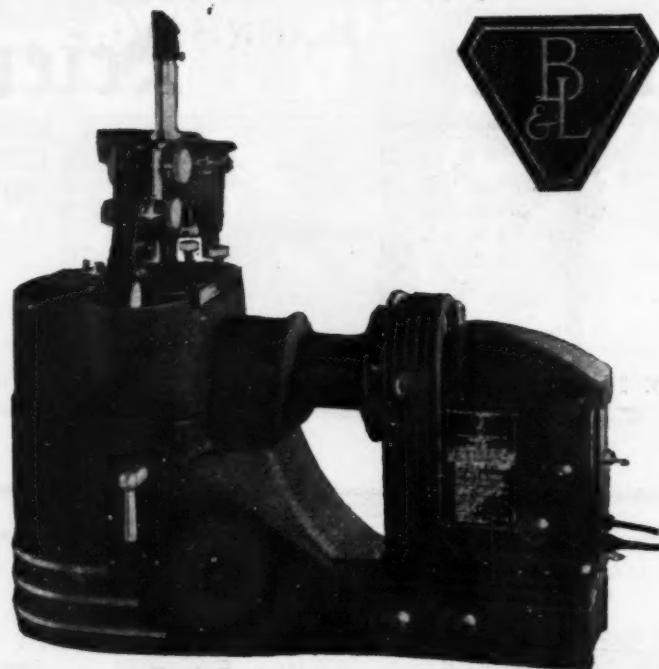


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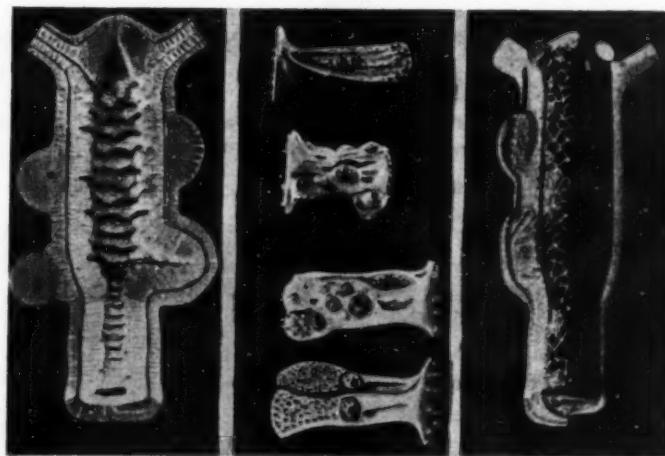
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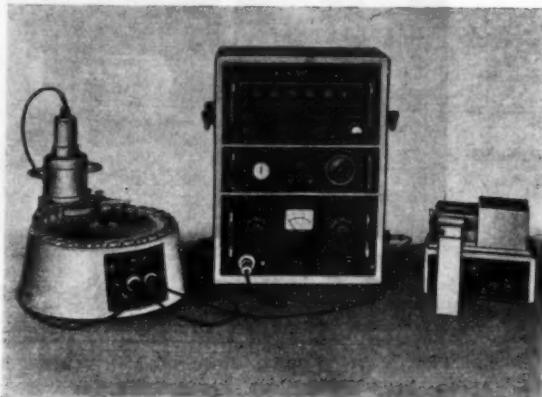
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Current Science



Vol. XXIV]

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THE ELASTICITY OF CRYSTALS*

THE materials used in engineering construction are mostly polycrystalline solids and their elastic behaviour is of the utmost practical importance. It follows that the subject of the elasticity of crystals is of more than merely academic interest. Of recent years the importance of its study has greatly been enhanced by several circumstances. The experimenter today can in many cases work with synthetically prepared crystals of large size and good quality. He has at his disposal several new techniques enabling him to determine their elastic behaviour and obtain precise results. These techniques are mostly based upon the production of waves or standing oscillations in the crystal with the aid of piezoelectric oscillators. These latter oscillators are themselves

of importance in technical acoustics and communication engineering. The subject also stands in the closest relation to the structure of crystals as revealed by X-ray diffraction and spectroscopic studies. It is thus an integral part of the rapidly developing physics of the solid state.

2. THE NOTIONS OF STRESS AND STRAIN

The science of elasticity is based on the fundamental notions of stress and strain and—subject to a restriction on their magnitude—on the proportionality between them known as Hooke's law. The precise definition of stress and strain is thus a matter of fundamental importance. Such definitions have necessarily to be comprehensive. They have to cover cases where their magnitudes vary from point to point within the crystal and also cases in which the stresses and strains vary with time as in the theory of wave-propagation. It is essential, further, that they take account of the elastic anisotropy which all crystals exhibit, in other words, the fact that the effect of an impressed

*1. "On the Theory of the Elasticity of Crystals," by Sir C. V. Raman and Dr. K. S. Viswanathan; 2. "Evaluation of the Four Elastic Constants of Some Cubic Crystals," by Sir C. V. Raman and D. Krishnamurti. Memoirs Nos. 73 and 76 of the Raman Research Institute, Bangalore, *Proc. Ind. Acad. Sci.*, 1955, **42**, 51 and 111.

force depends on the direction in which it is applied.

An important remark which should be made here is that it is unnecessary to introduce atomistic considerations in defining stress or strain. This is obvious since the phenomena with which we are concerned are open to macroscopic observation. To take account of the variability of stress and strain with the location we define these quantities in relation to a particular point within the solid. The legitimacy of this procedure rests upon the fact that it is possible to imagine the volume of the substance to be divided into elements of such small dimensions that each element can be regarded as a mass particle and yet is large enough to justify its physical properties being assumed to be the same as those of the material in bulk. We are thereby enabled to specify the position of any volume element by its three co-ordinates in space and its state of equilibrium or of motion in terms of simple forces or tractions acting on the volume element.

3. THE ELASTIC CONSTANTS

The foregoing remarks are preliminary to a specification of stress and strain which is logically consistent with the approach made to the subject. We define stress in terms of the tractive force assumed to act on an infinitesimal area drawn through a given point within the solid. Since this area can be set normal to each of the three co-ordinate axes in turn and for each such setting the acting force can be resolved into three components parallel to these axes respectively, we have nine components of stress. Likewise, strain is expressed in terms of the difference in displacements of two neighbouring points within the solid. Since the line joining these two points can be set parallel to each of the three co-ordinate axes in turn and the difference of their displacements in each case can itself be resolved along each of these axes in turn, we have nine components to deal with. The stress-strain relationships of proportionality would in the general case thus involve 9×9 or 81 elastic constants. The well-known law of reciprocity which enables us to interchange the directions of force and displacement without change in the constant of proportionality between them results in the number 81 being reduced to $(9 + 36) = 45$ constants in all. Thus, it requires 45 elastic constants to describe the elastic behaviour of a triclinic crystal. For crystals of other classes, the number of independent constants is diminished by reason of their symmetry properties, the more so the higher the symmetry of

the crystal. The number of independent elastic constants in each case can be readily worked out using the formulæ based on group theory given by Bhagavantam. Table I exhibits the situation thus disclosed. The first column shows the symmetry class in the usual language of crystallography, while column II shows the subdivisions of those classes grouped together according to their elastic behaviour. The third column shows the number of independent elastic constants for these sub-classes.

TABLE I

Crystal system	Point Group (Schoenflies notation)	No. of Elastic Constants		
		General	Dynamic	Classical
Triclinic ..	All	45	36	21
Monoclinic ..	All	25	20	13
Orthorhombic	All	15	12	9
Tetragonal	C ₄ , S ₄ , C _{4h} D ₄ , C _{4v} , D _{2d} , D _{4h}	13 9	10 7	7 6
Trigonal	C ₃ , S ₆ D ₃ , C _{3h} , D _{3d}	15 10	12 8	7 6
Hexagonal	C ₆ , C _{3h} , C _{6h} D ₆ , C _{6v} , D _{3h} , D _{6h}	11 8	8 6	5 5
Cubic	T, T _h O, T _d , O _h	5 4	4 3	3 3

4. WAVE-PROPAGATION IN CRYSTALS

Writing down the equations of motion of the volume of elements of the medium in terms of the space variations of the stress components acting upon them, one can investigate the propagation of waves through the material. It emerges that in any given direction within the solid, three types of waves can be propagated, their velocities being different in each case and also varying with the direction. The wave velocity for each of the three types and for any particular direction of propagation is expressible as a function of the direction and of certain linear combinations of the elastic constants. The number of these combinations is less than the number of general elastic constants in each case. The number can be calculated from formulæ based on group theory and is shown in the fourth column of Table I.

5. REMARKS ON THE CLASSICAL THEORIES

Cauchy, the celebrated French mathematician of the 19th century, in his memoir presented

to the Academy of Sciences at Paris in the year 1822 proposed a reduction of the number of components of stress and strain from 9 to 6 in each case. His arguments will be found reproduced in numerous text-books and indeed they form the basis of the mathematical theory of elasticity as hitherto developed. A critical examination shows however that those arguments are not sustainable. In the case of the strain components, the reduction was sought to be justified by eliminating movements which were thought to be rigid body rotations. Actually the quantities eliminated are differential rotations of the same nature as those which appear in the deformation of solids by torsion or flexure and which are quite as much a part of the elastic deformations as extensions and contractions. Hence their elimination is not justified. The argument on which the reduction of the number of stress components from 9 to 6 was based was that the angular momenta of the tractions acting on a volume element taken about each of the co-ordinate axes in turn and summed up should vanish. But since by definition the stresses are assumed to be in the nature of tractive forces acting on volume elements small enough to be regarded as single mass particles, no consideration of angular momenta is called for. Indeed, once we accept the definitions of stress and strain, it becomes logically imperative to take account of all the nine components of each.

On the basis of Cauchy's assumptions the stress-strain relations of proportionality are $6 \times 6 = 36$ in number and these by application of the reciprocity relationship reduce to $(6 + 15) = 21$ in all for a triclinic crystal. Their number is smaller for the crystals of higher symmetry classes and is shown in column 5 of Table I against each of them. The reduction in number of the stress and strain components from 9 to 6 is in effect equivalent to assuming that differential rotations within the solid play no part in the theory of elasticity and to imposing a corresponding restriction on the nature of the acting stresses. As already remarked, differential rotations play a fundamental role both in static deformations, especially in torsion, as also generally in wave propagation. In other words, the classical theory is of restricted validity confined to certain types of static deformation and to particular cases of wave propagation. Since however it has been employed to interpret experimental data in other cases as well, it is useful to express the 21 constants in terms of the more general 45 con-

stants, thereby enabling the latter to be evaluated from the existing data of experiment.

6. THE DATA OF EXPERIMENT

As will be seen from Table I the simplest cases of all are crystals belonging to the Td and the Oh classes of the cubic system. The general theory gives four elastic constants which may be designated as respectively d_{11} , d_{12} , d_{44} and d_{45} while in the classical theory we have only three constants which have been designated as C_{11} , C_{12} and C_{44} . The linear combinations of the elastic constants which determine the velocities of wave propagation are in the former theory d_{11} , d_{44} and $(d_{12} + d_{45})$ while in the classical theory they are C_{11} , C_{44} and $(C_{12} + C_{44})$. Likewise, the expressions for the bulk modulus in the new and the old theory are respectively $(d_{11} + 2d_{12})/3$ and $(C_{11} + 2C_{12})/3$. Since the number of elastic constants of these classes is four, while the number of linear combinations that can be determined by dynamic measurements is three, it follows that at least one additional determination by static methods is necessary to enable all the four constants to be evaluated. The most appropriate of such determinations appears to be the bulk-modulus of which very precise measurements have been made by Bridgman and his collaborators at Harvard. It is necessary of course to correct the isothermal static value of the constant to obtain the adiabatic bulk modulus. Many other points have to be borne in mind: the bulk modulus reduced to zero pressures should be used; both the static and dynamic determinations have to be reduced to the same temperature of observation and finally the nature of the material used in the two cases has to be comparable.

In Table II are shown for 16 different crystals of the Td and Oh classes, the values of the four elastic constants calculated in the manner explained. The three constants of the older theory are also shown in the table. The latter are those which appeared to be the most reliable values obtained by ultrasonic techniques, while the former were obtained by combining them with the value for the adiabatic bulk-modulus. The values of C_{11} and d_{11} are in each case identical; likewise those of C_{44} and d_{44} . But C_{12} and d_{12} are different and such difference is a measure of the failure of the three-constant theory to represent the actual elastic behaviour of the crystal. The difference between d_{44} and d_{45} also expresses the same situation in another way.

Certain general features emerge from the Table. For all the four alkali halides which are

TABLE II
Elastic constants in 10^{11} dynes/cm.²

Substance	C_{11}	C_{12}	C_{44}	d_{11}	d_{12}	d_{44}	d_{45}
NaCl	4.877	1.232	1.269	4.877	1.34	1.269	1.16
KCl	4.038	0.663	0.628	4.038	0.779	0.628	0.512
KBr	3.455	0.56	0.507	3.455	0.655	0.507	0.412
NaBr	3.87	0.97	0.97	3.87	1.22	0.97	0.72
LiF	11.9	5.38	5.34	11.9	4.5	5.34	6.22
MgO	28.76	8.74	15.14	28.76	11.27	15.14	12.61
AgCl	6.05	3.64	0.624	6.05	3.482	0.624	0.782
Diamond	95	39	43	95	35.9	43	46.1
Ge	12.88	4.825	6.705	12.88	4.04	6.705	7.49
Si	16.56	6.386	7.953	16.56	6.56	7.953	7.78
ZnS	10.79	7.22	4.12	10.79	6.17	4.12	5.17
CaF ₂	16.6	4.87	3.58	16.6	4.29	3.58	4.16
Al	10.56	6.39	2.853	10.56	6.29	2.853	2.953
Ca	16.92	12.25	7.55	16.92	12.81	7.55	6.99
Ni	25.26	15.51	12.3	25.26	16.01	12.3	11.8
Ag	12.4	9.34	4.61	12.4	8.89	4.61	5.06

soluble in water, C_{12} is less than d_{12} and likewise d_{45} is less than d_{44} . This regularity of behaviour taken in conjunction with the reliability of the data in these cases makes it clear that these differences are real and justify us in concluding that the elastic behaviour of cubic crystals cannot be expressed in terms of three constants, but needs four. Diamond, germanium, zinc blende and fluorspar also exhibit a parallel behaviour which is the reverse of that shown by the four water-soluble alkali-halides. In their cases, C_{12} is decidedly greater than d_{12} , while *per contra* d_{44} is less than d_{45} and these differences are numerically more striking than in the case of the alkali-halides. Magnesium oxide for

which the data are reliable exhibits a noteworthy behaviour; the differences between C_{12} and d_{12} and likewise between d_{44} and d_{45} are in the same sense as in the alkali halides but proportionately much larger. Differences of the same order of magnitude but in the opposite sense is shown by lithium fluoride. In the case of the metals crystallizing in the face-centred cubic system, we also find differences between C_{12} and d_{12} and between d_{44} and d_{45} but they are not always in the same sense. This is a feature which need not surprise us in view of the very great differences exhibited by these metals in other respects.

C. V. RAMAN.

RADIATION EFFECTS IN COVALENT AND IONIC CRYSTALS

IN a paper presented at the Geneva Conference on the Peaceful Uses of Atomic Energy, J. H. Crawford, Jr., of the Oak Ridge National Laboratory, U.S.A., reports that the physical properties of many non-metallic solids, such as diamond, quartz and various crystalline salts undergo extensive changes when these materials are exposed to the high energy radiations emanating from nuclear reactors. Changes in colour, magnetic behaviour, density and crystal structure as indicated by X-ray studies have been observed.

For example, diamond specimens take on a dark, opaque appearance and their density decreases by 4% after extended bombardment

with high energy neutrons which result from the fission of U 235 atoms. Once damaged to such an extent, annealing at high temperatures (which usually restores material to its initial conditions) can no longer produce a colourless crystal. Exposure of natural crystalline quartz to reactor radiations produces, relatively speaking, an enormous expansion of the crystals. As much as a 14% decrease in density has been observed. After exposure, X-ray studies indicate that the normal, ordered array of atoms which make up the quartz structure has been completely destroyed and the material is essentially structureless like a glass.

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DOSAGES FROM NATURAL RADIOACTIVITY AND COSMIC RAYS

THE radiation dosages that people receive from the natural radioactivities and cosmic rays have been calculated and listed by W. F. Libby in an article reported in *Science* (1955, 122, 57).

The dosages in milliroentgens per year for exposures directly over ordinary granite, typical sedimentary rock, and open oceans vary from 50 to 150. For comparison purposes, it is interesting to note that in the United States, the average exposure rate from total fallout from atomic tests on 1 Jan. 1955 was about 1 mr./yr. The total dose during 1954 probably averaged about 15 mr., principally because of the Pacific tests in the spring.

The dosage resulting from cosmic radiation was calculated from ionization chamber data, and from these the dosages were calculated at altitudes up to 20,000' and at the latitude of 55° N. (geomagnetic) as well as at the geomagnetic equator. The cosmic ray dosage at sea-level varies from 33 to 37 mr./yr. It should be mentioned that the biological effects per unit energy may be larger for cosmic radiation, because it consists of high-energy particles rather than gamma radiation.

The natural radioactivity in the human body also contributes an appreciable dosage. A value of 19 mr./yr. is due to potassium; carbon contributes 1.5 mr./yr., while the minute amount of radium present in the human body produces a dosage of more than 50 mr./yr. It is estimated that the hard gamma rays of potassium contribute about 2 units out of the 19. This leads to the interesting result that in a packed crowd

the radioactivity from the potassium in one's neighbours' bodies contributes an additional dosage of 2 mr./yr.

It is found that various ordinary, but somewhat unusual circumstances in normal living produce exposures far in excess of the quantities mentioned above. A wrist watch worn 24 hr./day that has a luminous dial assumed to have 1 microcurie of radium per watch—a figure perhaps slightly larger than the average—would give the central body including the sex organs, a dosage of about 40 mr./yr. An airplane pilot flying a 24-hour-day with an instrument panel consisting of 100 dials with 3 microcuries of radium each would receive, at an average distance of 1 yard, a dosage of 1300 mr./yr.

Dr. Libby has also checked whether the dosages calculated and listed by him are essentially correct by comparing them with some direct measurements reported by various observers. It is interesting that the variations in natural dosage are large, and that under certain conditions the natural dosage may be nearly 100 times higher than the minimum—the dosage of sea-farers. The fallout dosage rate in the United States on 1 Jan. 1955, namely, 1 mr./yr., was only 2% of this lowest natural dosage rate. Of course, during a test period when bombs are fired, the fallout dosage rates may approach, or somewhat exceed, the natural dosage rate for a few days before decay, but weathering processes will reduce them in a few weeks to rates that are small percentages of the natural background.

ATOMIC POWERED X-RAY MACHINES

A TOMIC-POWERED X-ray machines, which require no electric power for operation, developed at the U.S. Army Medical Research Laboratory, Fort Knox, Kentucky, were described at the Geneva Conference on Peaceful Uses of Atomic Energy.

Recent advances have made a 22 lb. unit possible. The new unit is powered by a tiny pellet of radioactive thulium metal, smaller in diameter than a pencil eraser, and only about 2 mm. thick. Thulium is refined into pure metal and then activated in a modern reactor. A small opening in the lead shield permits the rays to come from the machine when a thin gold shutter is released. The rays from the unit are available 24 hours a day and the tiny pellet is good for about one year, after which it can be reactivated in a reactor.

A second type uses radioactive strontium. The beta particles emanating from it are directed toward a metal disc or target, where they are converted to X-rays. Work in this field is presently directed toward designing a machine weighing less than 10 lb. and usable for about 20 years without recharging.

Pictures taken with present atomic X-ray machines are without doubt inferior to those taken with modern X-ray machines that require electric power. However, tests show that the isotopic X-ray machines are good enough at present to locate bone fractures and any foreign bodies such as pieces of metal. Considering the rapid strides that are taking place in atomic research, the future of the atomic X-ray machine looks very promising.

THE INHIBITION BY SULPHANILAMIDE OF THE METABOLISM OF HISTIDINE IN GERMINATING SEEDS

V. M. SIVARAMAKRISHNAN AND P. S. SARMA

University Biochemical Laboratory, Madras-25

THE catabolism of histidine is mediated by the specific enzyme histidase,¹ which occurs in animal livers (especially cat liver), and also in the bacterium *Pseudomonas fluorescens*.² The presence of histidase in plants has not been reported. By the action of liver histidase, histidine is hydrolytically decomposed into ammonia, and a product, which on treatment with strong alkali or acid, yields a molecule of glutamic acid, one molecule of formic acid, and one more molecule of ammonia.¹ Thus glutamic acid or a derivative of it, is a product of the decomposition of histidine. Subsequent investigations (reviewed by Tabor³) have established urocanic acid, L^a-formamidinoglutaric acid, and N-formyl glutamic acid as intermediates in the conversion of histidine to glutamic acid, formic acid and ammonia.

Since the decomposition of histidine gives rise to formic acid, a single carbon unit, the vitamins, p-aminobenzoic acid and folic acid may be expected to take part in the degradation of histidine. Recently, Tabor and collaborators⁴ have reported that feeding of histidine to folic acid-deficient rats increases the urinary excretion of a compound, which, on decomposition, gives a molecule each of glutamic acid, formic acid, and ammonia. This compound has now been identified to be α -formamidinoglutaric acid.⁵ Our previous investigations⁶ have shown that, during germination of greengram seeds (*Phaseolus radiatus*), the addition to the growth medium, of sulphanilamide, an antivitamin for p-aminobenzoic acid, produces an accumulation of histidine, due presumably to an inhibition of its catabolism. With the availability of histidine labelled with C¹⁴ in the α -carbon atom from the Tracerlab Inc., Boston, the degradation of histidine in germinating seeds, its possible conversion to glutamic acid, the inhibition by sulphanilamide of this conversion, and also the quantitative significance of this conversion in the overall metabolism of histidine have been investigated.

EXPERIMENTAL

The experiment consists essentially in germinating greengram seeds with radioactive histidine in the medium, isolating the glutamic acid as the hydrochloride, and histidine as nitra-

nate from the seedlings, and measuring the radioactivity in them.

25 g. of greengram seeds divided into five 5 g. lots were used for the germination. Each lot, after surface sterilization with 0.1% HgCl₂ solution and washing, was allowed to germinate inside a sterile 11 cm. petri dish containing a filter circle, and the sterilized medium. The medium consisted of 1.232 mg. of radioactive histidine, with an activity equal to 4.128×10^6 c.p.m., and sterile water to 24 ml., which is just enough for 72 hr. germination. Germinations were carried out in a sterile chamber in diffuse light for 72 hr. at room temperature, which varied between 28 to 31°C.

Similar germinations with medium containing sulphanilamide also (640 μ g./24 ml.) were conducted simultaneously to study the effect of sulphanilamide.

At the end of the germination, the seedlings as well as the petri dishes were washed, and the activity in the collected washings was determined. The seedlings were then hydrolysed with 6 N HCl for 22 hr., the excess HCl was removed by distillation in *vacuo*, the solution was diluted to precipitate out the humin, and then made up to a known volume. A sample of this solution was removed for the estimations of the amino acids, histidine according to Macpherson⁷ and glutamic acid according to Meister, Sober and Tice,⁸ as well as the total radioactivity after suitable dilution. The rest of the solution was used for the isolations. Carrier histidine (400 mg.) was added to facilitate the isolation of radioactive histidine.

From this solution, glutamic and aspartic acids were precipitated as their barium salts by Foremann-precipitation,⁹ and the glutamic acid then separated as the hydrochloride according to conventional procedures given by Block and Bolling.¹⁰ The glutamic acid hydrochloride was purified by repeated reprecipitations to constant activity. From the solution remaining after Foremann-precipitation, the barium was removed as sulphate, the solution acidified strongly with nitric acid, and then excess of silver nitrate solution added. The precipitated silver chloride was removed and the pH of the solution then adjusted to 7.4 with barium hydroxide solution, to precipitate the histidine as the silver salt. The histidine-silver salt was

then converted into pure histidine nitranilate, following closely the details given by Block and Bolling.¹⁰ Radioactivity measurements were carried out with 0·1 mg. samples spread out as uniform thin layers in stainless steel planchets, 2·4 cm. in diam., with a windowless gas-flow counter, connected to an autoscaler and an Eagle Present Counter. All counts were taken with a probable statistical error not exceeding 2%. No corrections were made for self-absorption.

RESULTS AND DISCUSSION

TABLE I

Distribution of radioactivity in greengram seeds germinated with α -C¹⁴-labelled histidine in the medium, for 72 hr.

	Control	Sulphanilamide treated
Activity supplied as histidine	2.064×10^7 c.p.m.	2.064×10^7 c.p.m.
Activity in washings ..	Negligible	Negligible
Activity in the hydrolysate	1.168×10^7 c.p.m.	1.506×10^7 c.p.m.
Activity of histidine in the seedlings	1.164×10^7 c.p.m.	1.424×10^7 c.p.m.
Degradation of histidine as % of activity supplied	43·6	31·0
Activity in glutamic acid	3.373×10^4 c.p.m.	2.148×10^4 c.p.m.
Activity in glutamic acid as % of total activity	0·1634	0·1041

It will be seen from Table I that, under normal conditions, there is a degradation of histidine to the extent of 43·6% in 72 hr. On the other hand, chemical determinations of histidine in the ungerminated seeds and 72 hr. germinated seedlings actually point to a net synthesis of histidine to the extent of about 19%. This would mean that, during 72 hours' germination, there is a degradation of histidine by about 43·6%, and a concomitant synthesis of about 62·6%, resulting in the observed net synthesis of 19%. Histidine, then, is in a metabolically active state in germinating seeds. Similar results have been obtained with glutamic acid also.¹¹ While estimations of glutamic acid in the ungerminated seeds and 72 hr. germinated seedlings showed a net fall in glutamic acid of only 35%, isotopic investigations revealed a degradation amounting to no less than 95%, pointing to a concomitant synthesis of about 60%, and hence to the high metabolic activity of glutamic acid in germinating seeds.

The investigations with these amino acids suggest, that other amino acids too, are probably in a metabolically active state, undergoing both degradation and synthesis at the same time.

The glutamic acid isolated has been found to be radioactive. Thus, there is a conversion of histidine to glutamic acid in plants also, even as in animals¹ and bacteria.² When sulphanilamide is added to the medium, there is a greater retention of radioactivity, and a lesser degradation of histidine. Sulphanilamide, thus, inhibits the catabolism of histidine. At the same time, there is a decrease in the radioactivity of glutamic acid. This suggests that sulphanilamide inhibits the conversion of histidine to glutamic acid.

While this conversion seems to be an established one, a comparison of the activities in histidine and glutamic acid throws doubt as to the importance of this conversion as a major pathway of histidine metabolism in this species. A loss of 43·6% of the total activity in histidine is accompanied by a gain in glutamic acid of only 0·1634%. An accumulation of 12·6% of total activity in histidine by sulphanilamide inhibition is accompanied by a loss of only 0·0593% of total activity in glutamic acid. Thus, the changes in the radioactivity of glutamic acid are only minor fractions of the changes in the activity of histidine. As such, this conversion does not seem to be a major pathway in the metabolism of histidine, even when due allowance is made for the rapid catabolism of glutamic acid during germination.¹¹

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LETTERS TO THE EDITOR

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DETERMINATION OF ULTRASONIC VELOCITY IN SOME COMPLEX CHLORIDES OF MERCURY

A NUMBER of workers¹⁻⁶ have shown that when solutions of $HgCl_2$ and KCl are mixed in different proportions, then complexes are formed if the ratio of the number of molecules of the two are as 1:1 or 1:2 or 2:1. In particular, the formation of the compound K_2HgCl_4 , and the occurrence of the ion $HgCl_4^{2-}$ have been definitely established. Evidence for the formation of the ion $HgCl_3^-$ has been obtained from surface tension,² Raman spectra³ and solubility measurements.^{4,5} In the present note, ultrasonic data are presented which confirm the existence of the ion $HgCl_3^-$.

Ultrasonic velocities were measured at 29°C. for the solution corresponding to the concen-

trations mentioned in Table I. All the solutions contained 20 g. of $HgCl_2$ in 250 ml. of solutions, while the concentration of KCl is as given in column 1.

TABLE I

Amount of KCl in g.	Ratio of number $KCl : HgCl_2$	Velocity metres/sec.
0.00	0 : 1	1484.9
2.75	½ : 1	1488.9
5.50	1 : 1	1400.6
8.25	½ : 1	1495.7
11.00	2 : 1	1501.2

On drawing a graph between the measured velocity and the corresponding amount of KCl added we do not get a uniform increase in

velocity, but there is a clear discontinuity in the curve at $KCl \cdot HgCl_2$, as shown in Fig. 1.

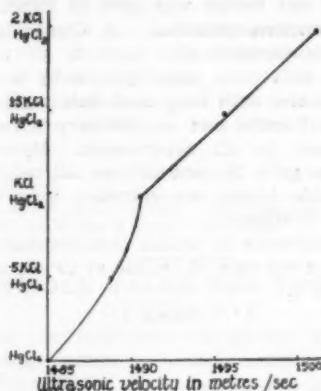


FIG. 1

This suggests the formation of a new compound in a solution of $KCl \cdot HgCl_2$ yielding the ion $HgCl_3^-$. The detailed paper will be published elsewhere.

Physics Department,
Lucknow University,
Lucknow, August 1, 1955.

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THE IMPORTANCE OF THE POINT OF INFLECTION IN THE VISCOSITY-TIME CURVE OF THE SLOW COAGULATION OF COLLOIDS

It has been clearly observed that under ordinary conditions the rate of slow coagulation has an autocatalytic character with most coagulators and the viscosity-time curves are therefore S-shaped. While studying the kinetics of slow coagulation of As_2S_3 sol, it has been observed that the points of inflection ($d^2x/dt^2 = 0$) in the viscosity-time curves obtained by adding different concentrations of the electrolyte are significant because they denote the same kinetic state in the process of coagulation. Hence these points may be considered to be governed by the same state of the size, shape and charge of the aggregated particles. In other words, the times corresponding to the points of inflection may be reasonably assumed to be such

as to give the same stage of coagulation attained by adding different concentrations of the electrolyte.

In previous communications,¹ the relation between the time of coagulation t and the concentration C of the electrolyte was expressed by the equation,

$$C = a + \frac{m/t}{(n+1/t)}$$

where a , m and n are constants. This equation can be reduced to the form

$$\frac{1}{C-a} = \frac{n}{m} t + \frac{1}{m}$$

where $1/(C-a)$ is linear with t .

The degree of coagulation was determined by measuring the relative change of viscosity given by $(T - T_0)/T_0$, where T_0 is the time of efflux without adding the coagulating electrolyte and T is the time of efflux after the addition of electrolyte at different time intervals. $(T - T_0)/T_0$ was then plotted against the corresponding time intervals for different concentrations of electrolyte, and the points of inflection were then determined from the curves as shown in Fig. 1. The reciprocal of the different times

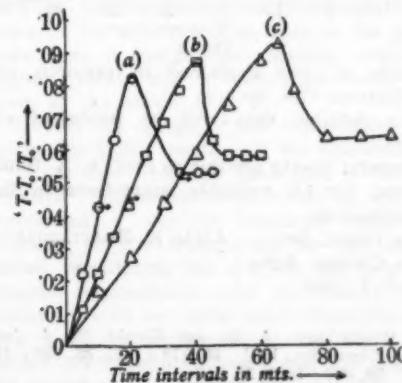


FIG. 1. Concentration of the As_2S_3 Sol—0.00 M,
Curve (a) → Electrolyte Concn. = 0.45 M
Curve (b) → Electrolyte Concn. = 0.45 M
Curve (c) → Electrolyte Concn. = 3.45 M

$(1/t)$ corresponding to the points of inflection obtained from the degree of coagulation and time curves of the As_2S_3 sol were plotted against the respective concentrations (C) of the electrolyte (KCl) used. The intercept obtained on the C -axis gave the value of the constant a , i.e., when $1/t = 0$ (see Fig. 2). Knowing a , $1/(C-a)$ was plotted against t and the curve was found to be linear, which confirms the

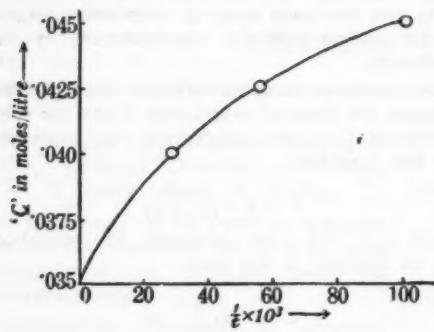


FIG. 2

validity of the new equation (Fig. 3). The constants m and n can also be determined gra-

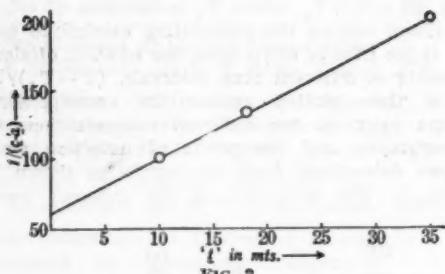


FIG. 3

phically as was explained in previous communications (loc. cit.).

The detailed data will be published elsewhere.

Grateful thanks are due to Prof. A. K. Bhattacharya, for his valuable suggestions in these investigations.

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POTENTIOMETRIC TITRATION OF AROMATIC AMINES WITH SODIUM NITRITE

MULLER AND DASCHELT¹ applied the potentiometric method to the titration of aromatic primary amines in acid solution with sodium nitrite. Concentrated solutions were used by them for the purpose and the influence of the acid concentration on the inflection potential was not investigated. Kolthoff² attempted to apply the method in the case of dilute solutions but without success. A complete investigation was therefore carried out.

The titration cell consisted of the same Muller electrodes¹ and a saturated potassium chloride salt bridge was used to eliminate the liquid junction potential. A Cambridge Verner Potentiometer was used in all titrations and the null point was detected by a ballistic galvanometer with lamp and scale arrangement. A micro-burette and an ordinary glass stirrer were used in all experiments. Hydrochloric acid (sp. gr. 1.16) and sodium nitrite solutions of suitable higher concentration were used in all the titrations.

The influence of amine concentration, investigated in the case of aniline at 19° C., is shown in Table I.

TABLE I

Strength of aniline solution in Molarity	Aniline by expt. in g./litre	Percentage error g./litre
0.0645	6.377	0.7
0.1075	11.181	0.6
0.1613	14.364	0.2
0.2150	20.510	0.0
0.3225	30.730	0.1
0.5376	50.643	0.2
0.6850	60.527	0.3
0.8600	80.191	0.4

It is evident from Table I that amine solutions of strength about M/4 can be accurately titrated with sodium nitrite solutions about 10 times more concentrated than the amine solutions.

The influence of the hydrochloric acid concentration, studied for the first time, is shown in Table II for *p*-toluidine.

TABLE II

S. No.	Hydrochloric acid (sp. gr. 1.16) present in 25 ml. of <i>p</i> -toluidine solution in g.	Inflection in potential at equivalence point (mV)
1	2.915	39
2	4.935	46
3	7.155	85
4	9.275	86
5	11.395	90

It is seen from Table II that about 8 g. of hydrochloric acid (sp. gr. 1.16) should be present in 25 ml. of the titrating solution to obtain the maximum rise in potential at the equivalence point, whereas Muller and Daschelt used only half this amount of acid for the same volume of solution.

The influence of temperature was also investigated and these titrations gave accurate results below 20° C.

G. SITARAMIAH.
RAM SWAROOP SHARMA.

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SINGLE VALVE SAW TOOTH GENERATOR

ONE of the relaxation oscillators, a blocking oscillator,³ can be used as a saw tooth generator to display the time base¹ on the cathode ray tubescreen. If the screen coupled blocking oscillator is operated on sinh-sin mode of operation, then the circuit is capable of giving a sawtooth waveform.

Fig. 1 shows a circuitry which produces a saw tooth waveform. The repetition rate is

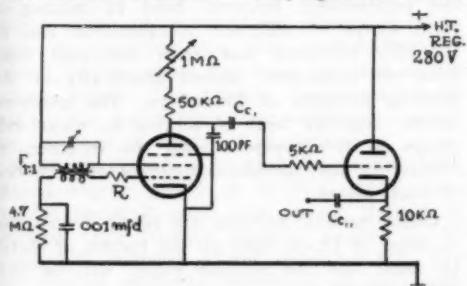


FIG. 1

determined by the primary inductance and the stray capacitance, which is approximately equal to $W^2/L_p c$ and the pulse length is given by,

$$T = \frac{\pi C \sqrt{L_p}}{\sqrt{C - g^2 L_p}}$$

where g = mutual conductance, C = stray capacitance, L_p = primary inductance.

Principally, the circuit drawn in Fig. 1 can be considered as a tight-coupled Hartley type oscillator, but in this case the screen grid is coupled to the control grid instead of anode.

When the H.T. is switched on, a certain amount of potential is developed across the screen winding of the transformer, this potential drop at the screen is inverted in the control grid winding, such that the control grid becomes positive, which causes a further incre-

ment in the total current and the current drawn by the screen. During the whole operation, the anode is kept at very low potential and therefore it has very little influence on the behaviour of the circuit. The feed-back as described above is sufficient to cause the first half-cycle of the oscillation to take place. The period of oscillation is determined by the transformer inductance and stray capacitance present. Due to the presence of the limiting resistor R , the resulting voltage at the control grid is such that the operation does not extend well into the non-linear region of the tube characteristic and therefore the flattened half of the sinusoidal current is not produced, as a result of that the sinusoidal alwaveform is present at the control grid (Fig. 2).



FIG. 2



FIG. 3

When the sine pulse rises from negative peak towards the zero potential, then to the positive maximum, it charges the capacity, which ultimately results into a linear saw tooth waveform at the anode (Fig. 3).

Though the design of the transformer determines the pulse length and the operation, still it is not free from the associated circuit components. The sweep duration can be varied by connecting a variable capacitor across the primary of the transformer or can also be varied by altering the gain of the tube. The general requirements and the design of the transformer do not differ much from the design data given by Benjamin.² If the circuit parameters are carefully chosen and the design of the transformer is within the specified values, the pulse length and the repetition rate can be predicted with fair accuracy.

The circuit given in Fig. 1 provides a free running sweep, the repetition frequency of which can be varied from 47 kc/s. to 59 kc/s. Available sweep at the output point is of 50 μ sec. duration approximately.

The experimental circuit described above, can be used where cheapness and fairly good accuracy is required. It can also be used for general purpose; the available frequency range is increased by having a transformer with a number of tappings in the primary and second-

ary and only one pair (turns ratio 1:1) is connected at a time in the circuit. With the help of this arrangement one can vary the sweep frequency from 30 kc/s. to 115 kc/s.

My thanks are due to Dr. K. K. Bose for his guidance.

Dept. of Electronics, V. V. R. INDULKAR,
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THERMODYNAMICS OF COPPER-NICKEL ALLOYS

IN recent years increasing attention has been paid to phase-diagrams for yielding useful thermodynamic data.¹ Particularly, eutectic systems have been analyzed and heat and entropy of mixing computed.² In spite of some of the recent developments in calorimetric technique,³ indirect methods have to be developed for estimating heat of mixing at higher temperatures and the same for solid alloys. Apart from its thermodynamic value, heat of mixing can throw valuable light on the nature of metallic bond in solid alloys. Accordingly we give below a method for computing heat of mixing of solid and liquid alloys from phase-diagrams of metallic systems forming complete series of solid solutions.

It has been experimentally observed that for a large number of non-ideal mixtures, heat of mixing can be represented by an equation of the following form^{4,5}

$$H_m = N_1 N_2 [A + B(N_1 - N_2) + C(N_1 - N_2)^2 + \dots]$$

where A, B, C... are empirical constants. Using Gibbs' method^{6,7} the equations for the slopes of solidus and liquidus curves can be readily deduced by assuming the above equation for heat of mixing. Assuming the heat of mixing to be temperature independent which is not an uncommon feature in metallic systems, the values of the constants can be determined from the observed slopes by the method of least squares.

In this connection copper-nickel system was re-examined which had been previously investigated by Seltz⁸ who calculated the solidus and liquidus curves from temperature and heat of fusion of respective pure components, assuming the solid as well liquid phase to behave

ideally. *Prima facie*, this assumption does not seem to be incorrect since the molar volumes of the two components in the two phases are approximately similar and the atomic arrangement in the crystal lattice is almost identical. In view of the specific nature of metallic bond,⁹ it is not proper to assume that such mixtures are ideal or regular. The solid phase would be regular in extremely rare cases, while the liquid phase may approximate to regular behaviour in a few cases. These conclusions are corroborated by the heat of mixing calculated according to above procedure with the help of observed solid-liquid equilibrium data.¹⁰ It is found that the heat of mixing for the two phases are given by the following expressions:

$$H_m (\text{for solid phase}) = N_1 N_2 [-1806 - 43030(N_1 - N_2) - 49890(N_1 - N_2)^2]$$

$$H_m (\text{for liquid phase}) = -5144 N_1 N_2$$

where N_1 and N_2 are the mole-fractions of the respective components in the specific phase. The form of the equation for liquid phase conforms to that for a regular mixture. In Fig. 1 the relationship between heat of mixing of solid alloys of different compositions and its Brinell's hardness has been indicated since both the properties depend essentially on the binding energies of the alloys. The predominantly negative heat of mixing in nickel-rich alloys is in agreement with the existence of λ-point in the specific-heat-temperature curves of such alloys.

Other metallic systems are being investigated in order to throw light on the nature of metallic bond and the detailed paper will be published elsewhere.

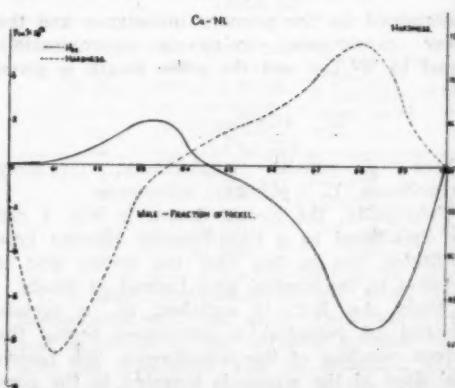


FIG. 1. Heat of mixing in (cal./gm. mole) and Brinell's hardness of Copper-Nickel alloys.

One of us (K. T. R. V.) is thankful to Council of Scientific and Industrial Research for a maintenance grant.

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VAPOUR PHASE CHLORINATION OF ETHANOL UNDER SILENT ELECTRIC DISCHARGE

Liquid phase chlorination of ethanol is commercially exploited for the manufacture of chloral, but no work has been reported in the vapour phase. The present investigation was carried out under the latter conditions, under the influence of electrical excitation.

Streaming chlorine at 6 ml./sec. mixed with alcohol vapour raised at 65-70°C. from commercial rectified spirit was passed through a Siemens' type all-glass ozonizer excited by 50 cycles A.C. potential of the order 3-8 KV. The less volatile products condensed on the walls of the ozonizer and eventually trickled down in the alcohol-feeding flask; the volatiles were carried over by the effluent gases and condensed in a receiver cooled with freezing mixture.

The condensate, in its less volatile part, was found to contain H^+ and Cl^- ions and quantities, the relative proportions of which varied with duration of discharge and other factors such as applied potential, etc., of chloral, dichloro-acetaldehyde and dichloro-acetaldehyde-acetal with small amounts of chloral alcoholate. In the volatile fraction, besides the smaller quantities of above products, paraldehyde was found in appreciable quantity.

Working with 50 ml. of rectified spirit for every run of 2 hours discharge, 10-15 g. of dichloro-acetaldehyde acetal were obtained, the formation of which appears to be favoured by

higher applied potentials. The total of chloral and dichloro-acetaldehyde formed ranges from 8-15 g.; for want of an adequate technique of separating and differentially estimating them, it has not been possible so far to determine exact proportions of these in the mixture. The Cl^- and H^+ ions formed are almost in equivalent proportions indicating the absence of appreciable amounts of other acidic products.

Compared with the results of vapour phase chlorination carried out independently but without the application of silent electrical discharge, the quantities obtained are very large, indicating thereby the remarkable role played by the electric discharge. It has been observed further that the yield of any one or more products can be selectively controlled by an appropriate adjustment of the operative electrical factors.

Further work is in progress to explore the possibilities of the reaction and the mechanism of chlorination.

Sincere thanks of the authors are due to Principal S. S. Joshi for his kind interest, and to Dr. R. H. Sahasrabudhe for criticism and useful suggestions.

Dept. of Chemistry, O. P. MALHOTRA,
Banaras Hindu University, B. N. TRIVEDI,
Banaras, August 9, 1955.

CONSTITUTION OF MAXIMA SUBSTANCE B

The isolation of a substance designated as Maxima substance B, m.p. 126-28°, from the roots of *Tephrosia maxima* Aers. was reported in a recent note published from these laboratories.¹ The composition of the substance corresponds to the formula $C_{21}H_{18}O_5$. This formula is based upon the degradations described herein and some others not recorded here and it supersedes the formula suggested provisionally in the earlier communication. It is neutral in character, being insoluble in aq. sodium hydroxide and giving no colour with ferric chloride. It contains no methoxyl but it gives a positive test for the methylenedioxy group. Hydrolysis with 12% aqueous sodium hydroxide gives formic acid (qualitative reactions) and piperonylic acid (mixed m.p.), proving its nature as an isoflavone with a methylenedioxy group in the 3':4'-positions of the side phenyl nucleus. Treatment of Maxima Substance B with methanolic hydrogen chloride or glacial acetic acid-sulphuric acid yielded a hydroxy compound, whose properties including hydrolysis with 12% aq. sodium hydroxide and those of its acetate

and ethyl ether indicated its probable identity with the natural isoflavone pseudobaptigenin. This identity was established by a direct comparison of the ketone obtained by alkaline hydrolysis with synthetic pseudobaptigenin and of the main phenolic compound itself with synthetic pseudobaptigenin.

The formation of pseudobaptigenin (phenolic) from the non-phenolic Maxima Substance B under the influence of methanolic hydrogen chloride or acetic-sulphuric acids is to be explained by assuming that Maxima Substance B is a 7-0-alkyl ether of pseudobaptigenin, which undergoes dealkylation under the influence of these reagents. That the alkyl residue is most probably $(\text{CH}_3)_2\text{C} = \text{CH}-\text{CH}_2-$ is indicated by a comparison of the molecular formulae of Maxima Substance B and pseudobaptigenin, by the formation of acetone (identified through the dinitrophenylhydrazone) on oxidising Maxima Substance B with chromic acid and from general biogenetic considerations and analogy with other well-known natural products.

S. RANGASWAMI.
B. V. RAMA SASTRY.

Dept. of Pharmacy,
Andhra University, Waltair,
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ACTIVE RELAXATION OF UNSTRIATED MUSCLE PRODUCED BY PROTEOLYTIC ENZYMES

The transverse muscle of the stomach of the frog (*Rana tigrina*) has the interesting property that its contractile mechanism is actively relaxed by substances that denature proteins.¹⁻⁴ According to modern views, denaturation consists of an alteration of the specific internal structure of the protein wherein the closely folded peptide chains unfold.⁵ Similarly, the contraction of muscle is supposed to be due to folding of the contractile protein; so relaxation would be due to unfolding of the muscle proteins. The process of relaxation of muscle would be similar to the denaturation of proteins.

In the mechanism of enzymatic hydrolysis, it is presumed that the first phase of the enzymatic action is the combination of the enzyme with its substrate; the second phase of the enzymatic hydrolysis is the hydrolytic cleavage

of the substrate while it is bound to the enzyme forming a complex. The formation of this complex loosens probably some bonds of the substrate so that the enzyme is then able to act. The polypeptide chains might be at first unfolded and then undergo hydrolytic cleavage.

The unfolding action of the proteolytic enzymes can be tested on the heat-killed frog's stomach muscle. Experiments were performed on unloaded strips of circular muscle of the stomach of the frog, *Rana tigrina*. Both dying muscles and heat-killed muscles were used. The muscles were killed by heating to 50° C. for 10 minutes. They were then treated with various concentrations (0.2 to 1%) of enzymes: trypsin, pepsin and papain. The enzymes were dissolved in frog saline, and the pH was adjusted to the requisite value, 8 for trypsin, 1-2 for pepsin, and 1 or 6-7 for papain. The control muscles were immersed in saline containing boiled enzymes; trypsin and pepsin were boiled for 10 minutes and papain for 15 or 20 minutes. The enzymes were allowed to act for 24 hours at 37° C.

The action of trypsin was most satisfactory. In 41 experiments it caused active relaxation of the heat-killed muscle by 13 to 70%. In 3 experiments it had no action, and in 3 other experiments it caused contraction. The concentration of the enzyme has to be suitably adjusted so as to be mild, as contraction appears to occur at the hydrolytic stage, and active relaxation as a preliminary effect. Pepsin did not produce any relaxation, but the acid medium actively relaxed some muscles. It appears, therefore, that pepsin requires the acid medium for the preliminary unfolding action of the latter. Papain also caused active relaxation from 10 to 38%. Dying muscles were also relaxed by trypsin.

These experiments therefore indicate that hydrolysis of proteins by enzymes is preceded by unfolding of the polypeptide chains. This might be done by the enzyme itself, or by the medium in which the enzyme acts.

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AMINO ACIDS IN THE RESERVE NUTRITIVE MATERIAL OF THE EGG OF *PILA VIRENS* (LAMARCK)

In recent years the technique of paper chromatography has been employed to study the embryonic development of animals in relation to changes in the amino acid composition in developing tissues and in the reserve substances in the eggs. But so far only the eggs of the sea urchin (*Berg¹*) and a few other invertebrate eggs (Holtfreter et al.⁵) have been investigated.

As a preliminary study in the chemical embryology of *Pila virens*, a qualitative determination of the utilisation of the amino acids of the albuminous material surrounding the embryo was carried out. The embryo of *Pila*, as Ranjah⁷ and Nagaraja⁸ have shown, is surrounded by an albuminous fluid, bounded by a thick 'albumen' layer, the two together being usually termed 'albumen' in zoological literature. The albuminous fluid and the solid 'albumen' constitute the reserve nutritive material for the developing embryo. The present note records the more important features in the utilisation of the free amino acids as well as those of the hydrolysates of this reserve material.

For the preparation of the hydrolysates, the procedure described by Giri et al.⁴ was adopted, and for the determination of the free amino acids the method described by Block.² The amino acids were identified using the circular paper chromatographic technique by running mixed chromatograms and by spotting the known and unknown in the same chromatogram.

At the commencement of development in the freshly laid egg there are altogether 18 amino acids in the hydrolysate of the reserve food material, 9 of which appear as distinct bands and the remaining have overlapping bands (Fig. 1). Amino acids having very nearly the same R_f values do not separate into distinct bands as in the case of bands 1, 3, 7 and 8 in the chromatogram shown in Fig. 1. "Multiple development technique" as described by Giri and Rao,³ however, gave better separation of the overlapping amino acids.

The sequence of disappearance of some of the amino acids in the hydrolysate obtained from the food material during development is as follows : 8-cell stage—proline; 16-cell stage—cystine; 32-cell stage—arginine, serine, proline and cystine; gastrula stage—only alanine, glutamic acid; threonine, glycine and histidine could be identified with certainty and they too are in low concentration, appearing as rather faint bands in the chromatogram. By the trochophore stage, when the organogenesis of the em-

bryo commences, the amino acid content of the hydrolysates of the reserve food material becomes too low in concentration to permit a clear chromatographic analysis.

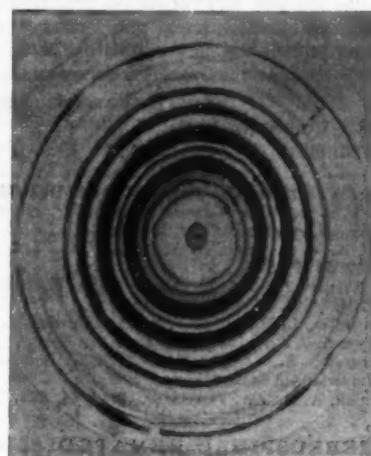


FIG. 1. Circular paper chromatogram of reserve food material hydrolysate in the freshly laid egg.

1. Leucine + Isoleucine ; 2. Phenylalanine ; 3. Valine + Methionine ; 4. Tyrosine ; 5. Proline ; 6. Alanine ; 7. Threonine + Glutamic acid ; 8. Glycine + Serine + Aspartic acid ; 9. Asparagine ; 10. Arginine ; 11. Histidine ; 12. Ornithine ; 13. Cystine.

For the determination of the free amino acids in the reserve food material six stages were examined, viz., (1) fertilized egg, (2) 2-cell stage, (3) 32-cell stage, (4) blastula, (5) gastrula, and (6) trochophore. The initial stage showed the presence of alanine, glutamic acid, glycine, histidine and arginine. Glycine is the only free amino acid present in good concentration in all the stages. Arginine is present only in the initial stage of the fertilized egg, being absent in all subsequent stages. Glutamic acid disappears in the trochophore stage. Alanine and histidine are present in low concentration in all the stages. Table I shows the distribu-

Stage	Amino acids				
	Alanine	Glutamic acid	Glycine	Histidine	Arginine
Fertilized egg	.. F	F	I	F	F
2-cell stage	.. F	F	I	F	..
32-cell stage	.. VF	VF	I	F	..
Blastula	.. F	F	I	F	..
Gastrula	.. F	F	I	F	..
Trochophore	.. F	..	I	F	..

F, faint ; VF, very faint ; I, intense.

tion of the free amino acids in the reserve food material during development.

The significance of the above findings in relation to morphogenesis is under investigation. My thanks are due to Prof. R. V. Seshaiya for suggesting the problem, and for guidance and instruction, and to the Government of India for the award of a senior research scholarship.

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CEREBROSPINAL NEMATODIASIS AMONG BOVINES IN SOME MALNAD TRACTS OF MYSORE STATE

An obscure disease among cattle characterised by paraplegic or complete paralytic symptoms is prevalent since several years as seasonal enzootic in Hosnagar, Sagar and Sorab taluks of Shimoga District, Mysore State, bordering South and North Kanara Districts of Madras and Bombay States respectively. Bovine paralysis in South Kanara District with exactly similar symptoms was observed by Viswanathan (quoted by Ramakrishnan and Ananthapadmanabhan⁸) and a similar disease among cattle and buffaloes in North Kanara District was reported by Kulkarni.⁶ Enzootic bovine paraplegia in Mysore State is non-febrile and occurs in acute, subacute and chronic forms. In acute cases the onset of complete paralysis is sudden and death results in about 2-3 days, while in subacute and chronic cases the disease starts with immobility of tail and paraplegia followed by gradual progressive paralysis of the anterior parts and the course extends from a week to a month or even more.

Microscopic, cultural and biological tests with blood, cerebrospinal fluid, emulsions of spleen, brain and spinal cord did not reveal any specific bacterium, virus or protozoan parasite. The possibility of latent trypanosomiasis, nutritional deficiency, particularly of calcium, phosphorus and magnesium was also ruled out. The spinal cord and brain from four typical cases of bovine paraplegia (2 acute and

2 subacute) were removed after post-mortem examination conducted within 3 hours after death and preserved in 10% formalin. After 48 hours of preservation the tissues were taken out for embedding and sectioning and the formalin which had become turbid was centrifuged. The sediment was examined for nematode larvae as suggested by Niimi (quoted by Innes²). Microscopic examination of the nervous tissue sediment obtained after centrifugation of the fixative which contained the brain and spinal cord of two acute cases revealed four complete microfilaria and in the thick smears made from the emulsion of the softened portion of spinal cord and brain, stained with Hæmotoxylin Eosin and Giemsa's stains, bits of microfilariae were found. All these larvae were sheathed. Among four complete microfilariae observed, the largest one (Fig. 1) measured 850 μ in length and 25 μ

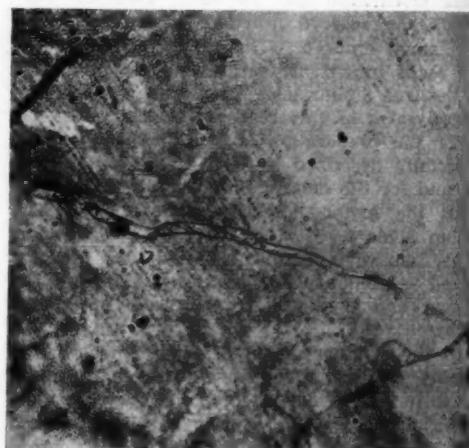


FIG. 1. Nematode larva found in the spinal cord of a cow, acute case of bovine paraplegia (larva found in the tissue sediment got by centrifugation of the lumbar portion of the spinal cord of Case No. 1), $\times 48$. thick at the head end and the smallest one measured 300 μ in length.

Histological sections of the brain and spinal cord in 3 out of 4 cases had the following lesions. There was acute softening in which not only the myelin degeneration was present but also the ground substance was loosened and destroyed. Focal cellular infiltration, liquefaction, micro-cavitation and definite changes in axis cylinders such as swollen scanty, disordered and irregularly globose axis cylinders within the transversely cut tube representing myelin sheath were observed in H.E. stained

sections. On the whole the histological picture of the spinal cord in three of the four cases, resembled the lesions of focal liquefactive encephalomyelomalacia as described by Innes.¹ The most important finding was the detection of sections of immature nematodes other than microfilaria in the lumbar portion of the spinal cord of two acute cases. Definite identification of the nematode, whose microfilariae and immature forms were observed in the spinal cord, was not possible. In the endemic area of Mysore State where bovine paraplegia is prevalent, a large number of blood-sucking flies are found and further investigations on the possibility of some blood-sucking insect being involved in transmission of the infective larvae is under way.

This is the first record of cerebrospinal nematodiasis among bovines. Previously, it has been found in other domestic animals by various workers.^{2-5,7}

I am thankful to Dr. P. M. Narainswamy Naidu, for guidance and to Dr. N. S. Krishna Rao for confirming my findings.

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SUCCINIC DEHYDROGENASE IN THE NEUROSECRETORY CELLS OF THE THORACIC GANGLION OF THE CRAB

Three types of neurosecretory cells, designated A, B and C, have been described in the thoracic ganglion of the crab *Paratelphusa hydrodromous* (Herbst.) by Parameswaran,¹ based on their histological differences and size. While studying the physiology and structure of these cells, it was observed that the A and B types of cells contain succinic dehydrogenase.

Thin slices of tissue were prepared with a sharp blade from freshly dissected thoracic ganglion. After a rapid wash in distilled water, the slices were placed in incubating media and kept at 37° C. Control sections were treated with sodium malonate added to the incubating mixture. Shelton and Schneider's method using neotetrazolium and Seligman and Rutenberg's method using blue tetrazolium (Pearse²) were employed. By both techniques, no indication

of succinic dehydrogenase was demonstrable in the C-type of cells. B-Cells always showed a general presence of the enzyme in their cytoplasm. In A-Cells the picture appeared to be somewhat variable. The cytoplasm in many cells show finely distributed and dense granular localisations of the enzyme, but in certain cases they were comparatively few and in other cases they were practically wanting. When abundant, the presence of diformazan (according to Seligman and Rutenberg's technique) granules appear bright blue with a shade of violet (Fig. 1). When the enzyme con-

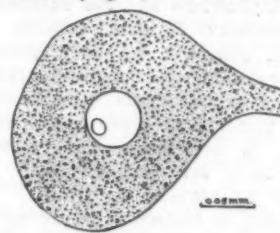


FIG. 1

tent was lower, besides some diformazan there was a large number of red monoformazan granules which indicate the low dehydrogenase activity. Probably this difference in the reactions of A-cells may be due to the nature and amount of secretory material in these large neurons.

The slices with A-type of cells become coloured in about 5 minutes when treated according to Shelton and Schneider's method. The rapidity of development of colour is suggestive of the higher enzyme content of these cells.

The cyclical development of succinic dehydrogenase in the A-Cells suggests a probable significance of these cells in the regulation of metabolism of the crab. Matsumoto³ has recently announced the chromatophoretic activity of the B-Cells of the thoracic ganglion of the crab *Eriocheir japonicus*; nothing is known about any of the functions of the other cells.

We are grateful to Prof. C. M. Francis, Medical College, Trivandrum, for the gift of the tetrazoliums, and Prof. R. V. Seshaiya, Anna-malai University, for the gift of succinate.

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CRUSTACEANS IN RELATION TO UNDERWATER TIMBER STRUCTURES

VERY little is known of Indian crustacean borers whereas wood-boring crustaceans of other countries have been studied by several authors like Calman,¹⁻³ Johnson,⁴ Menzis and Mohr.⁵ Hence a survey of the crustaceans (isopods and amphipods) in association with submerged timber piles, pillars and catamarans of the Madras coast was undertaken.

The following eight species—the sphaeromids, *Sphaeroma vastator* sp. Bate, *S. walkeri* Stebbing and *Exosphaeroma* sp.; the oniscids *Metoponorthus pruinosis* Brandt, *Oniscus asellus* Linnaeus and *Porcellio scaber* Latreille; the armadillid *Armadillidium vulgare* Latreille and the ligid *Ligia exotica* Roux have been found to bore into wood. Nine other species of Crustacea found in association with underwater timber structures are probably only foulers, and may not be harmful to timber. Though they are treated as foulers, they are not sessile as true foulers are. These are the sphaeromid *Cilicaea latreilli* Leach; the cirolanids, *Cirolana pleonastica* Stebbing, *C. elongata* M.E.; the idotheids, *Idothea gracillima* Dana, *Synidotea variegata* Collinge; the amphipods, *Stenothoe gallensis* Walker of stenothoid; the gammarid, *Elasmopus pectenicrus* Bate; the corophiid, *Corophium madrasensis* Nair and the caprellid, *Protogeton* sp.

The borers reported from the temperate waters, *Sphaeroma destructor* Richardson, *S. peruvianum* Richardson, *Limnoria lignorum* Rathke, *Chelura terebrans* Phil. are not found in the Madras waters. The most important borers of the Madras coast are *Sphaeroma vastator*, *S. walkeri*, *Exosphaeroma* sp. and *Metoponorthus pruinosis* which cause extensive damage to wooden structures made out of *Tectona grandis* (Teak), *Mangifera indica* (Mango), *Xylia xylocarpa* (Irul), *Cedrella* sp. (Red cedar) and *Terminalia* sp. These timbers are extensively used in jetties and catamarans. The abundance of these in infested timbers may be gauged from the fact that as many as 100 individuals of all ages can be collected in one cubic inch of wood. *Sphaeroma vastator* and *S. walkeri* measure about 10.5 mm. in length with uniform grey colour and differ in the nature of the telson and mandibles. The young ones resemble the adults except in size and colour, being white. Their propagation is so great that as many as 25 to 30 juveniles can be collected from a single brood-pouch. The holes excavated in the wood measure about 13 mm. deep and 3 mm. in dia-

meter. In a single hole more than one may be found huddled together. *S. walkeri* has been reported from Visakhapatnam harbour.⁶ *Exosphaeroma* sp. resembles *E. yucatanum* Richardson, but differs from it and other established species and a fuller account of this, which is probably a new one, will be given elsewhere.

The oniscid-borer, *Metoponorthus pruinosis*, occurs abundantly in the crevices of catamarans which are frequently drawn ashore for drying. It measures about 8 mm. in length with flattened body and the abdomen abruptly narrower than the thorax. This has also been reported from Visakhapatnam.

The ligid, *Ligia exotica*, is black, about 30 mm. in length, which has developed a marine and wood-boring habitat. The other borers were collected from wooden pieces washed off on the shores at Portonovo, Negapatam and Tuticorin beaches. All the foulers except *Cilicaea latreilli*, occur abundantly in the Madras harbour along with borers and other sedentary organisms.

I thank Prof. C. P. Gnanamuthu for his suggestion and guidance in carrying out this work. University Zoology T. K. SRINIVASAN, Res. Lab., Madras, August 8, 1955.

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FLOWERING OF VOLVOX IN A FRESH-WATER LAKE IN LUCKNOW, INDIA

In the course of investigations on fresh-water plankton of Uttar Pradesh, we observed a sudden flowering of *Volvox* in the months of July and August 1954. Observations on flowering and disappearance of plankton species have been recorded by past workers in India, but they deal only with marine forms. On the other hand, publications on *Volvox* in India, by some leading algologists such as Apte,¹ Carter,² Iyengar³ and others, are confined mainly to South India, although Rao⁴ made some observations on *Volvox* species from shallow rain-water pools in Lucknow. But no quantitative data on *Volvox* as a component of fresh-water plankton are available, nor are any data available regarding flowering, fluctuations and peak periods. *Volvox* was obtained in our routine plankton hauls, collected early in the

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morning, with the help of a half-meter Nansen plankton net. Plankton samples were fractionated by means of Lea-Gibbon's sub-sampler and the required part was transferred to the counting slide under the binocular microscope and, after numerical counts were made, the percentage of each organism was calculated.

The outburst of *Volvox* was noticed in the last week of July, and the crop was at its bloom for about 2 weeks, the water being light green in colour during this peak period. The species has been identified as *Volvox carteri* Stein, and our collections contain the various developmental and life-history stages of the species. The percentage composition of the plankton was determined by us, and the percentage of *Volvox* was found nearly constant in the last week of July and the first week of August. There was, however, a gradual decline during the rest of August. In September (Fig. 1) there was a sudden fall in

the percentage composition, and the number of *Volvox* decreased considerably in the month of October and November till there was a total disappearance of the crop in the month of December. The other components of the plankton were copepods, cladocera, crustacean larvae, insect larvae, rotifers and statoblasts of bryozoa; but crustaceans were in a majority.

It is quite evident from our observations that the *Volvox* crop was at its peak for about 2 weeks, during the last week of July and the first week of August. The entire period of maximum occurrence of *Volvox carteri* Stein can be stated to be from July to September. The water of the lake was not green throughout this period, excepting for the two weeks in July and August.

Besides this, it has been observed that the amount of *Volvox* by volume and weight, as also on percentage basis, appears to vary inversely with the amount of crustaceans from the same lake (Fig. 2). It would appear that this is the first record of an inverse correlation between *Volvox* (phytoplankton) and crustaceans (zooplankton) in fresh-water plankton in India.

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ALGINIC ACID CONTENT OF SOME OF THE COMMON SEAWEEDS OF THE GULF OF MANNAR AREA

Of the many commercially valuable products obtained from seaweeds, alginic acid (a polymer of d-mannuronic acid), and its salts have come to occupy a very important place. As in many other fields, the exploitation of the marine resources in India is still in its rudimentary stage and very little is known about the alginic acid content of the seaweeds of Indian waters, except for the work done on *Sargassum* of Cape Comorin.¹ This note records certain investigations made to estimate the alginic acid content of some of the common brown seaweeds of the Gulf of Mannar area. The investigation comprised experimental estimations of the total alginic acid content of five of the most common genera of the brown seaweeds of the area, followed by a study of

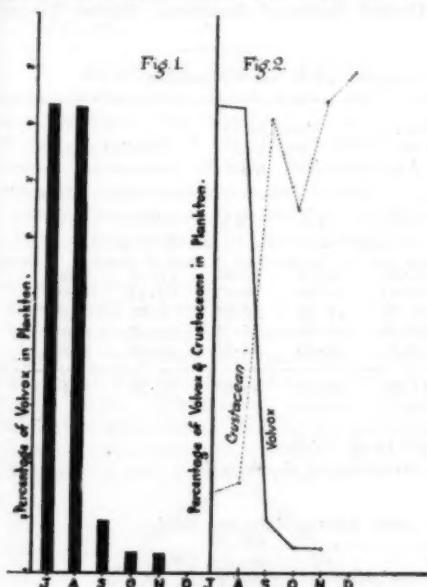


FIG. 1. Percentage of *Volvox* in total plankton. Co-ordinate denotes the percentage of *Volvox*, and the letters J to D on abscissa represent the months from July to December.

FIG. 2. Inverse correlation between *Volvox* and Crustaceans. Co-ordinate represents the percentages of *Volvox* (phytoplankton) and Crustaceans (zooplankton) and the letters J to D on the abscissa denote the months from July to December.

the actual yields obtained under practical conditions. The study was carried out on samples collected during the month of September and hence affords no indication of the seasonal variation in alginic acid content.

Palk Bay and Gulf of Mannar are well known for their rich algal growth in which a very large number of species are represented. The present study deals with five genera belonging to the group Phaeophyceae, viz. (1) *Sargassum*, (2) *Turbinaria*, (3) *Cystophyllum*, (3) *Hormophysa*, and (5) *Padina*. Since these seaweeds are available in large quantities, they appear to be the most suitable raw material for commercial exploitation. Separation of species has not been attempted in the case of *Sargassum* and *Padina* because of the difficulty in distinguishing them in the field. Further, specific differentiation of these seaweeds will be of little importance in any commercial extraction of alginic acid. However, care has been taken to concentrate on the most common species of the genera.

The estimation of the actual alginic acid content of these seaweeds were carried out by the method described by Cameron, Ross and Percival.² The actual yield of alginic acid from these seaweeds were determined by Stanford's method as described by Tressler,³ the percentage value being calculated on air-dry basis (Table I).

The percentage of moisture in the seaweeds were determined by heating the sample in an air-oven at 105°C. to constant weight. The results obtained are given in Table II.

From Tables I and II it can be inferred that *Sargassum*, *Turbinaria*, *Hormophysa* and *Cystophyllum* contain a fairly good percentage of alginic acid ranging from 15.63 to 19.22% and in practice yield from 13.58 to 17.64%. The most common genera of brown seaweeds of this area are *Sargassum* and *Turbinaria* and the yield of alginic acid from these compares well with that of *Macrocystis pyrifera*, which is one of the chief sources of alginic acid in the United States of America. Hence *Sargassum*

TABLE I
Alginic acid content estimated and the actual yield on extraction

<i>Sargassum</i> spp.		<i>Turbinaria conoides</i> (J. Ag.) Kutz		<i>Cystophyllum muricatum</i> (Turn) J. Ag.		<i>Hormophysa triquetra</i> (L.) Kutz		<i>Padina</i> spp.	
A %	B %	A %	B %	A %	B %	A %	B %	A %	B %
17.96	17.90	17.96	16.17	16.54	13.50	18.10	17.38	11.62	8.00
20.40	17.64	18.30	15.52	15.84	13.80	18.30	16.55	10.21	8.52
19.00	18.17	18.10	16.44	14.44	13.66	18.30	16.83	8.80	8.26
19.36	16.86	17.96	15.38	15.48	13.36	18.10	16.71	10.56	8.65
19.36	17.20	18.10	16.30	15.84	13.60	18.30	16.90	10.56	8.80
Mean	19.22	17.55	18.08	15.96	15.63	13.58	18.22	16.87	10.35
									8.45

A—Percentage of total alginic acid estimated on air dry basis.

B—Percentage of actual yield obtained on extraction, on air dry basis.

TABLE II
Moisture content in the seaweeds, just cast ashore (air-dry basis)

Expt. No.	<i>Sargassum</i> spp. %	<i>Turbinaria</i> <i>conoides</i> (J. Ag.) Kutz %	<i>Cystophyllum</i> <i>muricatum</i> (Turn) J. Ag. %	<i>Hormophysa</i> <i>triquetra</i> L. Kutz %	<i>Padina</i> spp. %
I	..	81.86	84.14	84.31	84.74
II	..	81.25	83.88	84.66	85.35
III	..	83.15	83.11	86.94	83.59
IV	..	83.48	83.54	84.37	83.87
V	..	85.30	83.97	86.10	83.44
Average	..	83.01	84.13	85.28	84.20
					83.22

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sum and Turbinaria hold out good prospects in any scheme for developing the alginic acid industry in India. Though the yield of alginic acid in *Cystophyllum* is low, this seaweed may also be considered as a good raw material in view of its availability in fair quantities.

My grateful thanks are due to Dr. N. K. Panikker and Sri. K. Chidambaram for the help received during the course of this study. This work was done while the author was on the staff of the Fisheries Department of the Madras State and is published with the permission of that Department.

Central Marine Fisheries Research Station,
Mandapam Camp, August 23, 1955.

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RUST ON GRAPE FRUIT

DURING March 1951 Grape fruit (*Citrus paradisi* Macfad.) was observed to be severely affected by a rust in the citrus orchard of Ali Sagar, Nizamabad District, Hyderabad State, where the climate is moist and humid. A preliminary examination revealed the presence of minute pustules on both the surfaces of the leaves. Severe infection is caused to the leaves and defoliation occurs.

Uredo citri sp. nov.

Uredia amphigenous, mostly hypophyllus, isolated or in groups, subepidermal, erumpent, pulverulent, opening by a central pore. Paraphyses none. Uredospores sessile, spherical, obovate or sub-globose, hyaline to sub-hyaline, minutely echinulate, thick-walled, germ pores indistinct, $14.5-20 \times 10-18 \mu$ (Fig. 1).



FIG. 1. Section of uredium ($\times 63$.)

Hab. on leaves of *Citrus paradisi* Macfad.
Collected at Ali Sagar during March 1951.

The assistance of Sri. V. Ravindra Nath is gratefully acknowledged.

Division of Plant Pathology,
Govt. Main Exptl. Farm,

Himayetsagar, Hyderabad-Dn.,
February 5, 1955.

DEFICIENCY AND TOXICITY EFFECTS OF BORON ON THE PHYSIOLOGY OF BARLEY

THE importance of micro-elements in the nutrition of plants has been stressed by many workers.¹ Among such micro-elements, boron occupies an important position. Thus boron deficient barley was susceptible to *Erysiphe graminis*.² Deficiency of boron was limited to the sporogenous tissue, primary disturbances being in the cell-wall.³ While this was true of the deficiency effects, no systematic analysis of the toxicity of boron has been made in this crop. In view of the fact that no researches have been conducted on the growth and physiological characteristics of barley in relation to subnormal and supernormal concentrations of boron, a water culture experiment with (1) absolute deficiency; (2) normal dose; and (3) toxic dose of boron constituting five times the normal dose was conducted, with Hoagland's nutrient solution on barley var. C 251 in the cropping season of 1949-50. Daily aeration and change of solution twice every week was maintained to induce true response of the treatments as indicated in an earlier paper.⁴

Boron deficiency was found to result in stunted growth of plants. Leaves remained thin and underdeveloped. Leaf number on the primary shoot of boron deficient plants did not vary appreciably from the leaf number of the primary shoot of complete nutrient plant. But yellowing and drying was markedly increased. It appeared that boron deficiency reduced the life-span of the leaves which showed tendency to dry out much earlier than the control. Colour of the leaves was also poorer than that of the complete nutrient culture. Chlorotic regions were developed in mature leaves with marked uneven distribution of pigments. In contrast to the deficiency cultures, toxic boron cultures were found to be taller with the colour of leaves approaching that of the complete nutrient plants. The leaves in the toxic boron cultures, however, showed development of brownish spots, beginning from the leaf tip and extending rapidly towards the base. This was so marked that even the fourth leaf showed dried out patches. The leaves showed early desiccation and death.

Comparative physiological responses of the deficiency, normal and toxic boron cultures (Table I) showed that the normal plants contained as a rule highest concentration of chlorophyll a, chlorophyll b, carotin and xanthophyll, as compared to the deficiency or toxic cultures. It was also noted that the normal plants

TABLE I
Physiological characteristics of barley in relation to deficiency and toxicity of boron

	Apparent assimilation*	Real assimilation*	Respiration*	Chlorophyll $\delta\ddagger$	Chlorophyll $\delta\ddagger$	Carotin†	Xanthophyll†	Total green pigments†	Total yellow pigments†	Total green/yellow	
Boron deficient cultures	..	2.04	2.56	0.51	1.48	1.55	0.0019	0.0279	3.03	0.0298	101.6
Complete nutrient cultures	..	5.60	6.76	1.16	4.47	3.86	0.0048	0.0037	8.33	0.0085	980.0
Boron toxic cultures	..	1.83	2.74	0.91	3.18	0.98	0.0022	0.0021	4.16	0.0043	967.4

* mg. $\text{CO}_2/100 \text{ sq. cm. leaf area/hour}$; † mg./10 g. fresh weight of leaf.

had relatively higher rate of apparent and real assimilation and respiration than deficient or toxic plants. No marked differences between the latter two were evident (Table I). Concentrations of boron higher or lower than that used for the normal plants were therefore less useful in improving both general growth and physiological attributes like photosynthesis, respiration and pigment content of barley.

Plant Physiol. Lab., K. N. LAL.
College of Agriculture, M. S. SUBBA RAO.
Banaras Hindu University,
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AN INTERSPECIFIC HYBRID IN ORYZA

Oryza sativa, Linn. (cultivated rice) has been crossed with some wild species in the genus, and Ramiah¹ has discussed the previous work. Potential cross combinations between species other than *O. sativa* are very large, but only a few have been recorded.^{2,3} Observations on one such interspecific hybrid are given here.

Two species of African origin were used in this cross. One parent, *O. eichingeri*, Peter., has 48 chromosomes. The other parent, *O. glaberrima*, Steud., is 24-chromosomal and is cultivated in West Africa. The particular parent *O. glaberrima* used in the cross had long sterile lemmas and can be described as *O. glaberrima* var. *grandiglumis*. *O. eichingeri* was used as the pollen parent. Though the parents were fertile, the hybrid was completely sterile and

is being kept alive by vegetative propagation. Back-crossing with either parent failed to give any seed. The pollen sterility in the hybrid was shown by the absence of well-filled pollen grains in iodine mounts.

Genetical Characters.—The following characters of the *O. eichingeri* parent behaved as dominants in the F_1 : spreading habit, lax divided panicles, reduced sterile lemma and hairy shattering spikelets. This behaviour of the characters in the F_1 is parallel to that recorded in *O. sativa* (Ramiah¹). The awn length and ligule length were greater than in either parent. The hybrid had green apiculus like *O. eichingeri* and not the pigmented apiculus of *O. glaberrima* parent. This character behaviour in F_1 is exactly the reverse of that recorded in *O. sativa* where purple apiculus character is dominant to green. In flowering duration (when sown in July), in plant height and spikelet size, the hybrid was intermediate between either parents. The random occurrence of trifid stigmas, a character present in *O. glaberrima*, was absent in the hybrid.

Cytological Observations.—The sections of the root tips of the hybrid prepared by the paraffin technique showed that the mitotic chromosomes were 36 as expected. The chromosomes showed some differences in size (Fig. 1).



FIG. 1. Mitosis in the F_1 hybrid. $2n = 36 \times$ c.a. 2800 magnification.
but their smallness prevented detailed study.
Meiosis was studied in both the parents and in

TABLE I
Multivalent frequency in *O. eichingeri* and *F₁* hybrid

		Maximum				Minimum				Mean			
		I	II	III	IV	I	II	III	IV	I	II	III	IV
<i>O. eichingeri</i>	..	2	22	2	8	0	8	0	1	0.3	15.4	0.3	4.0
<i>F₁</i> hybrid	..	19	6	5	0	14	4	2	0	16.7	4.8	3.2	0

the hybrid by propionocarmine smears. In the diploid *O. glaberrima*, the meiosis was normal, 12 bivalents being regularly formed. In the tetraploid *O. eichingeri* and in the triploid hybrid, multivalents occurred in the M.I. stage and the frequencies are given in Table I.

It can be seen that quadrivalent formation occurs in *O. eichingeri*. Associations are mostly terminal. In this species, the trivalents with corresponding univalents occurred in 10 out of 40 cells observed and this could have arisen by falling apart of a chromosome from a quadrivalent.

There were no quadrivalents in the *F₁* hybrid and the maximum number of trivalents was only 5. Smears of anthers in the hybrid showed that only some of the P.M.C. were dividing. In these, anaphase irregularities occurred and the movement of chromosomes was as shown in Fig. 2. The univalents, bivalents and tri-

of 8 quadrivalents occurs in the tetraploid parent and therefore 8 autosyndetic bivalents can be formed amongst the 24 *O. eichingeri* chromosomes in the hybrid. It is therefore inferred that *O. eichingeri* must have evolved by autoploidy or segmental allotetraploidy. The occurrence of trivalents in the hybrid could be due only to pairing of some of *O. glaberrima* chromosomes with the autosyndetic pairs and it is seen that 5 chromosomes of this parent are homologous to 5 in the basic 12-chromosomal genome of *O. eichingeri*. In this connection it may be noted that the genus *Oryza* has evolved as a secondary allotetraploid with two different 5 chromosome basic species.⁴

On the same hypothesis, one of the basic complements (5 chromosomes) would appear to be common to the two parents (*O. glaberrima* and *O. eichingeri*).

Central Rice Res. Inst., H. K. SHAMA RAO,
Cuttack-4, R. SEETHARAMAN.

Orissa, August 22, 1955.

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FIG. 2. Meiosis in the *F₁* hybrid. Early Anaphase : 22-I, 2-III and 4-II.

valents move to poles, irregularly. This irregular segregation is the presumed cause of gametic sterility. The tetrads did not mature to form full pollen grains.

The chromosome pairing behaviour in *O. eichingeri* and in the hybrid indicates that autosyndesis occurs in the hybrid. A maximum

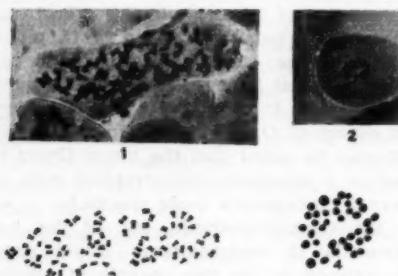
STUDIES IN THE CYTOLOGY OF *OCIMUM KILIMANDSCHARICUM* GÜRKE

CYTOTOLOGICAL investigations into the genus *Ocimum* is confined, so far, to a few observations made by Russian workers and reported by Darlington and Janaki Ammal.¹ These observations were made on *Ocimum gratissimum* ($2n = 64$), *O. sanctum* ($2n = 64$), *O. canum* ($2n = 64, 128$) and *O. canum* \times *O. gratissimum* ($2n = 64, 128$).

In the present report the chromosome studies in the species *Ocimum kilimandscharicum* Gürke have been incorporated. Preparations of

somatic chromosomes have been made from root-tips obtained from seeds collected from our own plantation at Sukna near Darjeeling² and also from those kindly supplied by Dr. Dhingra, Harcourt Butler Technological Institute, Kanpur, and Controller of the Essential Oil Scheme in the United Provinces. The material was fixed in *p*-dichlorobenzene at 10-15° C. for 2½-3 hours, followed by aceto-orcein squash.³ Meiotic stages were studied from plants grown in the experimental garden of this college. The temporary aceto-carmine squashes were made permanent following the usual procedure.

Observations revealed 76 chromosomes in the somatic cells (Figs. 1 and 3). The length of



FIGS. 1-4

Fig. 1. Photomicrograph of the somatic metaphase stage of *O. kilimandscharicum* showing 76 chromosomes. The split nature of the chromosomes is to be noted ($\times 900$ approx.).

Fig. 2. Photomicrograph of the meiotic metaphase I of the same plant showing 38 bivalents in the polar view ($\times 400$ approx.).

Figs. 3 & 4. Camera lucida drawings of the same plates ($\times 700$ approx.). Chromosomes in Fig. 3 are slightly spaced apart.

the chromosomes varied from 2·2-1·5 μ approximately. Metaphase plates brought out by the same technique showed diplo-chromosomes.

In meiotic metaphase plates of pollen mother cells 38 bivalents were observed in the polar view (Figs. 2 and 4). The length of the bivalents varied from 1·5-2 μ approximately.

Presidency College,
Calcutta,
June 28, 1955.

J. K. CHOUDHURY.
A. K. BAL.
R. B. BOSE.

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EMBRYOLOGY OF EUGENIA BRACTEATA ROXB.

TIWARY,¹ PIJL² AND JOHNSON⁴ have studied polyembryony in several species of *Eugenia*. Material of *E. bracteata* was collected by the author in 1952, from the Horticultural Gardens, Saharanpur, and the observations made are briefly stated below.

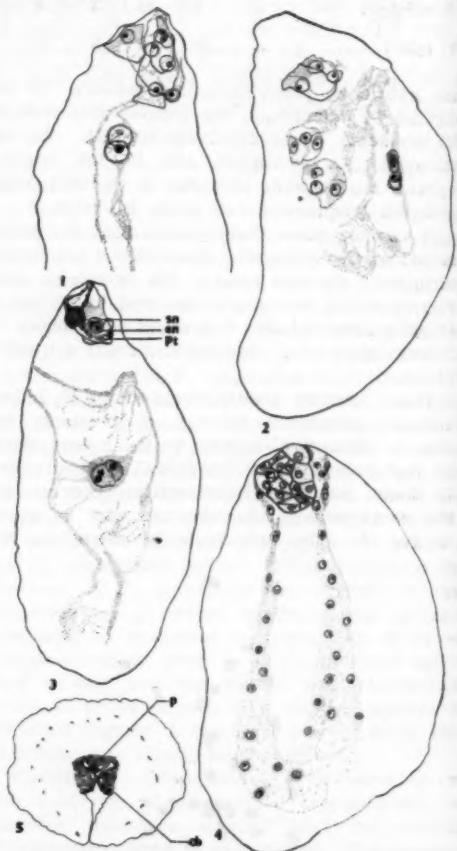


FIG. 1. 9-Nucleate embryo sac; the nucleolus of one of the polar nuclei became displaced during sectioning, $\times 1378$. FIG. 2. 13-Nucleate embryo sac, $\times 1378$. FIG. 3. Embryo sac showing pollen tube (pt) and an extra nucleolus in one of the polar nuclei. en - egg nucleus; sn - synergid nucleus, $\times 1378$. FIG. 4. Zygotic embryo and free nuclear endosperm, $\times 625$. FIG. 5. L.s. mature embryo showing plumule (p) and cotyledonary buds (cb), $\times 35$.

The bilocular ovary contains fewer ovules than either *E. jambolana* or *E. jambos*. A young ovule shows two integuments, each two-layered. The youngest stage showed a megasporangium with several parietal cells above it. There is a linear tetrad of mega-

spores of which the chalazal functions. Next come the two- and four-nucleate stages. Presumably an eight-nucleate stage occurs but the author was unable to observe all the eight nuclei, probably because the antipodal are ephemeral. The commonest stage was one with a three-celled egg apparatus and two juxtaposed polar nuclei.

Frequently, the synergids are not organized as cells. Their nuclei travel down and join with the polars. In such cases, therefore, the egg and four polar nuclei are seen. Other embryo sacs showed a 3-celled egg apparatus and 3 or 4 polar nuclei, i.e., a total of 6 or 7 nuclei excluding the antipodal. In one embryo sac a 9-nucleate condition was seen, 7 cells at the micropylar end and 2 functioning as polars (Fig. 1). In another 13 nuclei were observed : 4 appeared like polar nuclei and there were three groups of 3 nuclei each (some organized into cells) (Fig. 2). Still another embryo sac also showed more than 8 nuclei. It is possible that the supernumerary nuclei in the embryo sacs are either nuclei of nucellar cells, or the result of fusion of adjacent embryo sacs, or supernumerary divisions of original nuclei of the embryo sac.

A considerable amount of material of post-fertilization stages was sectioned. Pollen tubes were seen inside a few embryo sacs only. In Fig. 3 one of the polar nuclei clearly shows the existence of an extra nucleolus suggesting possible fusion with a sperm. In other cases the egg nucleus showed the presence of an extra nucleolus while the endosperm was free nuclear. Double fertilization, therefore, may be presumed to occur. In all cases the egg gives rise to the embryo. Neither in pre- nor in post-fertilization stages, was there any trace of the plasma-rich cells in the nucellus, destined to give rise to nucellar embryos. Nor was there any proliferation of the inner layer of the integument which later surrounds the embryo sac. Ovules showed only one embryo in the normal micropylar position (Fig. 4). Nucellar embryony is, therefore, absent in *E. bracteata*.

Buds are frequently produced from the cotyledons (Fig. 5), and it will not be surprising if such a seed on germination gives rise to several shoot apices and single radicle. This would not be a case of true polyembryony, however. Similar instances of the presence of buds in the axils of the cotyledons and the development of shoots from them have already been reported earlier by Tiwary² in *Cassia tora* and others.

I wish to thank Prof. P. Maheshwari for guidance and Prof. Y. Bharadwaja for facilities.

Dept. of Botany,
Banaras Hindu University,
Banaras-5, July 11, 1955.

S. K. Roy.

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ANATOMY OF OPEN AND COMPACT PANICLES IN *ORYZA SATIVA*

THERE are two types of panicles in the cultivated types of *Oryza sativa*, viz., the open and the compact. In the open ones the rachilla spread away from the rachis of the panicle at an angle of 45-90° and thus, the panicle appears to be open whereas, in the compact one all the rachillæ are closely pressed to the main rachis, and are almost parallel. At the time of the emergence of the panicles from the sheath all the rachillæ are appressed to the main rachis. In the open panicles, a small swelling of loose parenchymatous tissue is formed at the junction of the rachilla with the main rachis. As this tissue grows the rachillæ spread away from the rachis and when the spikelets mature and begin to ripen this tissue dries up and the branches are firmly fixed up in their position. The degree of angle these rachillæ make with the rachis depends upon the development of this tissue.

L.S. showed in both cases that some amount of parenchymatous tissue was found in the cortical region of the rachis. In the case of the open panicle, however, the epidermis of the rachilla is pushed towards the main rachis in the form of a swelling below which there are 14 to 15 layers of parenchyma cells. The vascular strands take a bend in the form of a loop in the open panicles in contrast to the straight path of the vascular strands in the compact panicles. Thus, the curved path of the vascular strands offers mechanical support to the parenchymatous tissue in pushing the rachilla away from the main axis to form the open panicle.

My thanks are due to Mr. S. Sampath of Central Rice Research Institute, Cuttack, for giving facilities to prepare the sections and to Prof. B. Samantarai and C. M. Bastia for preparing photomicrographs of the sections.

Utkal Krishi Mahavidyalaya, G. V. CHALAM,
Bhubaneswar, June 7, 1955.

REVIEWS

Optics—Lectures on Theoretical Physics. Vol. IV. By Arnold Sommerfeld. (Translated into English by O. Laporte and P. A. Moldauer.) (New York: Academic Press), 1954. Pp. xiii + 383. Price \$ 6.80.

The Academic Press has been publishing during the last few years English translations of the Lectures on Theoretical Physics given by the late Professor Sommerfeld at Munich. This is the last but one of the six volumes to appear and one more on Thermodynamics and Statistical Mechanics is under preparation.

In a way, this volume on Optics is a continuation of Vol. III on Electrodynamics, for Sommerfeld treats the subject of optics right from the beginning on the basis of the electromagnetic theory of light. One hopes that this would become the standard practice of teaching optics in this country at least at the post-graduate level. In the first chapter on reflection and refraction of light, Sommerfeld treats the phenomena not only at one boundary, but with two parallel boundaries (as in the Fabry-Perot or Lummer-Gehrcke interferometers) as a boundary value problem for the electromagnetic waves. The next chapter deals with problems connected with the velocity of light and concludes with a short section on photons. The next chapter on dispersion is perhaps the most elegant in the book in that it discusses the whole gamut of phenomena, refractive index and absorption in the visible, infra-red and ultra-violet, Zeeman effect, magneto-optic rotation, etc., in a single coherent treatment. Chapter IV deals with the essentials of crystal optics including the general case of an optically active, birefringent crystal. The theory of diffraction is treated in two chapters, which are the most elaborate in the book, containing rigorous solutions of many problems. Particular mention must be made of Rubinowicz's formulation of Kirchoff's solution in terms of the boundary of the diffracting object, which has been given in good detail. This approach is capable of being readily applied to practical problems involving irregular diffracting objects (*Proc. Ind. Acad. Sci.*, 1945, A-21, 165). The book ends with a discussion of the complementarity of the wave and corpuscular theories of light. A number of suggestive problems are appended to the book, and an outline of their solutions is also given.

This book is not an exhaustive treatise on optics and few references are given to original literature. But, on the other hand, the treatment of each topic is so lucid and thorough that it would serve eminently as a text-book for the study of optics, as indeed the original lectures of Prof. Sommerfeld were intended to be. In the reviewer's opinion, this should be the regular text-book in optics for the post-graduate classes in our universities, supplemented perhaps on the experimental side by the excellent treatise of Prof. R. W. Wood.

G. N. RAMACHANDRAN.

Physical Methods of Organic Chemistry. Part III. Second Edition. Edited by A. Weissberger. (New York: Interscience), 1954. Pp. xi + 417. Price \$ 8.50.

The first edition of this book appeared in two parts in 1945 and 1946, which were issued in a revised and enlarged edition in 1949. In an attempt to cover the more recent developments, the editor has wisely decided not to enlarge the first two parts, but to issue a third part incorporating new material. The present volume contains six chapters on new topics, such as electron microscopy, microspectroscopy, streaming birefringence, dielectric constant, radio-frequency spectroscopy and neutron diffraction. In addition, five chapters on viscometry, X-ray diffraction, electron diffraction, magnetism and radioactivity contain supplementary material to the earlier volumes.

It is obvious that these are not techniques which an organic chemist could readily adopt in his laboratory, for they not only require highly specialised equipment but also a person well versed in the field for their interpretation. Dr. Weissberger is obviously looking to the future in planning a volume of this type for the organic chemist, and he seems to be also fully aware of the situation, for these new chapters have been designed not so much to give full details of the methods as to give a comprehensive picture of the principles and the capabilities of each method. Selected references to recent literature are given for those who wish to enlarge their knowledge of a particular field.

Physical methods like those described in this book are being increasingly used not only in organic chemistry but even more in biochemis-

try and in the study of biological materials of high molecular weight. The three volumes will serve as an excellent source book to all those engaged in the analysis of the structure of chemical and biological materials.

G. N. RAMACHANDRAN.

Nuclear Energy and Its Uses in Peace. (A UNESCO Guidebook to the Age of the Atom), 1955. Pp. 76. Price 2 sh. 6 d.

In this booklet, Mr. Wendt offers a guided tour through the world of the nuclear fission, beginning with the days when the only source of radioactivity was radium—at \$100 a gramme—and when uranium was used mainly to colour glassware. With a wealth of clear illustrations, he discusses nuclear fuels, reactors, nuclear power, radioactivity and the fascinating field of radioactive tracers. Then he offers a picture of what the United Nations and its agencies have already contributed toward peaceful utilization of atomic energy and what lines their future contributions will take.

One conclusion to be drawn from this booklet is that, while the world may not be in the Age of the Atom, it is certainly at its threshold. The U.S.S.R. has announced that a full-scale 50,000 kilowatt power station will be in operation very soon. In England, a 50,000 kilowatt plant is to begin production early in 1956 and construction of a 60,000 kilowatt station has started in the United States. Other power plants are being planned in France, Canada, Norway, the Netherlands, Belgium and Switzerland.

The story of radioactive tracers told by Mr. Wendt is equally impressive. Use of a radioactive substance in fertilizer quickly tells what use plants make of the fertilizer. Radioactive tracers have been able to answer questions on the resistance to wear of piston rings, shoe soles, floor waxes, paints, concrete, car tyres, to name only a few.

Organic Solvents—Physical Properties and Methods of Purification. (*Technique of Organic Chemistry*, Vol. VII.) Revised Second Edition. By John A. Riddick and Emory E. Troops, Jr. (New York: Interscience), 1955. Pp. vii + 552. Price \$8.50.

This second edition of 'Organic Solvents' lists the important organic solvents classified systematically along with a number of their physical properties. Chapter I gives the classification of solvents under the major classes: (1) hydrocarbons, (2) compounds with one type of characteristic atom or group (hydroxy

compounds, esters, ethers, etc.), and (3) compounds with more than one type of characteristic atom or group (alcohol ethers, esters of hydroxy acids, etc.). Two hundred and fifty-four solvents have been listed.

Chapter II discusses the physical properties, criteria for their selection and estimation of physical constants from related data. The physical constants of the solvents have been tabulated in Chapter III. They have also been re-tabulated according to their boiling points, freezing points, dielectric constants and dipole moments. Criteria of purity are reviewed in Chapter IV, and the methods of purification of the solvents are given in Chapter V.

The need for the collection and classification of such useful data on the physical constants of important organic solvents is obvious, and the volume will be of immense help not only to the organic and physical chemists, but also to research engineers who have to use such data quite often during their investigations.

G. S. LADDHA.

The Theory of Cohesion. By M. A. Jaswon. (London: Pergamon Press), 1954. Pp. viii + 245. Price 37 sh. 6 d.

The book offers an introduction to the basic ideas and the mathematical details of the wave mechanical theory of the attractive forces in molecules and in solids. This is done in three steps. The first three chapters give a short résumé of the essential ideas of wave mechanics in about 50 pages. The treatment, as the author says, is not systematic, the purpose being more to give a general outline, so as to make the book self-contained. The next three chapters deal with the applications of perturbation theory to a study of multi-electron systems both in atoms and molecules. The various applications of the atomic and molecular orbitals are discussed in full detail, with special reference to the evaluation of binding energy. The last three chapters are concerned with the applications to solids, but only metals are considered. The Brillouin zone theory is given in detail, and particular reference must be made to the rather detailed account given of the recent developments in the theory of metals.

Considering that the book is Vol. II of the series of monographs on "Metal Physics and Physical Metallurgy", the particular stress laid on metals is to be expected. However, it is felt that the elaborate account given of wave-mechanical methods could have been profitably used to discuss the problem of cohesion in ionic and covalent crystals as well. As it is, diamond

is mentioned, but only the tetravalent bonds of the free carbon atom is really discussed.

A defect noted in notation needs to be mentioned. In writing down the matrix elements of the type $\psi^* | H | \psi$, the star in the first symbol is sometimes present but is mostly absent in the later chapters of the book. In the first reading of the book, the reviewer missed the small footnote in p. 65 that the asterisk is to be understood in the appropriate places, which explain this discrepancy. Even so, it is difficult to understand why in the same equation, as in Eq. (57), p. 85, there is a star in the numerator, but not in the denominator. A similar situation is noticed in numerous places, and it is necessary to consider whether the notation for matrix elements should not be suitably modified in a future edition. The book is not also free of misprints, e.g., the omission of dx in l. 13, p. 21 and of the horizontal line in Eq. 3, p. 27; the mis-spelling of one of the names at the bottom of p. 222. Some of the authors quoted in p. 222 are not to be found in the author index.

These are only minor points which in no way detract from the value of the book as a good introduction to the theory of the chemical bond.

Organic Analysis. Vol. II. Edited by John Mitchell Jr., I. M. Kolthoff, E. O. Proskauer and A. Weissberger. (New York: Interscience), 1954. Pp. viii + 372. Price \$ 8.50.

The present book is the second volume to be published in a series that has been planned to present annual reviews of both chemical and instrumental methods available for analysis of organic compounds. The emphasis, as in the first volume, is on methods of functional group analysis. The chemical determinations discussed include micro-determination of carboxyl groups, determinations of esters, nitro, nitroso and nitrate groups, and applications of lithium aluminium hydride to organic analysis. The instrumental techniques discussed are coulometric methods, application of polarography to organic analysis, methods based on reaction rate, phase solubility analysis and counter current distribution.

The chapters differ in their treatment of the methods and techniques discussed and in the amount of experimental details included for carrying out specific analyses. All the chapters provide a good theoretical discussion followed in some cases by tabular surveys of the applications of the particular reaction or technique discussed. The discussions on lithium aluminium hydride and counter current distribution

are timely reviews of methods which have been developed recently. The discussion on micro determination of carboxyl groups is perhaps out of place in a book of this nature since it deals only with procedures for simple titrations which are dealt with adequately in many textbooks. All the chapters are documented with references and the index included covers both Volume I and Volume II. The book will be of great value to chemists interested in organic analysis.

S. SWAMINATHAN.

(i) **Cumacea of the Benguela Current.** By N. S. Jones. (*Discovery Reports*, Vol. XXVII), 1955. Pp. 279-92. Price 6 sh. 6 d.

(ii) **The Wax Plug in the External Auditory Meatus of the Mysticeti.** By P. E. Purves. (*Discovery Reports*, Vol. XXVII.) (Cambridge University Press), 1955. Pp. 293-302. Price 10 sh. 6 d.

(i) The author, Dr. N. S. Jones of the Marine Biological Station, Port Erin, found five species in the material collected in March and September 1950, by R. R. S. William Scoresby off the south-west coast of Africa. Three species were new to science but the remaining two, which were best represented numerically in the collection, suggest that all the five cumacea were part of the rich population of the area off the west coast of Africa, and that they were brought up to the surface by upwelling and carried north and westwards by the Benguela current. The author makes the useful suggestion that other cumacea, especially the species of the genus *Iphinoe*, are probably widespread in southern Asiatic waters. The forms described were collected by vertical hauls especially at night. One wishes that the author had discussed more fully the factors behind the occurrence of these bottom-living forms used to low concentrations of oxygen, in the vertical hauls, since the presence of juveniles weakens the suggestion of nuptial swarms.

(ii) Like other features of adaptations of the Cetacea to aquatic life, the extremely small external ear passage, has attracted the attention of many since 1828. But owing to scarcity of material, accurate knowledge was not possible. The author, Dr. P. V. Purves of the British Museum, has now shown that a ceruminous wall plug extends from the base of the apparently closed ear-hole to the middle ear—a distance of 60 cm. in the specimens he examined. It would appear this is not really all wax, nor is it secreted

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centripetally, but outwards from the region of the eardrum. The size of the eardrum region (membrane and bony framework) does not increase with the growth of the animal, but the wax is secreted in layers (annually or biennially) so that the age of the whale can be computed from the laminations. These facts together with data regarding the plug being a good transmitter of sound, are additions to our knowledge of the biology of the Cetacea.

Both sections of the *Discovery Reports* are well illustrated and deserve to be included in the library lists of marine biological institutions.

C. P. GNANAMUTHU.

Animal Cytology and Evolution. By M. J. D. White. Second Edition. Cambridge University Press, 1954. Pp. xiv + 454. Price 45 sh.

Animal cytologists would welcome this second edition. In a rapidly-developing field like cytology, a book is likely to become out of date in the course of a decade. Since the publication of the first edition there has been considerable addition to our knowledge regarding the chemical composition of chromosomes and the adaptive significance of cytological polymorphism in natural populations. The recent advances have necessitated a re-orientation of the matter contained in the first edition.

The evolutionary significance of chromosome numbers was not apparent to the earlier students of the subject. Modern trends give one the hope that it may be possible "to raise evolutionary theory above the rather intuitive and semi-scientific state in which it exists today". Taking a long view of the processes of evolution, White remarks "that it must involve an endless cycle of duplications, heterochromatization of euchromatin and eventually deletions, a kind of circulation of genetic materials" (p. 377).

Among the host of workers, Goldschmidt alone believes that new species originate only as a result of a catastrophic repatterning of the caryotype. The glimpses we get of the nuclear changes during histogenesis suggest that a repatterning of the caryotype occurs during differentiation. Evolution of cell types should have preceded evolution of multicellular species and presentation of a comprehensive picture of the role of the caryotype in evolution may be possible only when more information is available on the changes that occur in the nucleus during histogenesis.

The presentation of facts is objective and it is only natural if in some cases the author has veered to his own interpretations of the phenomena. To a serious student the new edition is a mine of information and hence would be a welcome addition to any library.

M. K. SUBRAMANIAM.

Experiments in Organic Chemistry. Third Edition. By Louis F. Fieser. (D. C. Heath & Co, Boston), 1955. Pp. 360. Price \$ 5.25.

The third edition of Fieser's well-known laboratory manual is in some ways the best of the text-books on practical organic chemistry now available. It is completely modern in outlook and a worthy companion to Fieser and Fieser's *Organic Chemistry*. A slight lack of balance is common to both, but both are stimulating to read and use, and they provide an excellent background for research in organic chemistry.

The inclusion of semimicro and semimicro experiments, clearly demonstrating the possibility of giving students a wide range of experiments and training them effectively in the technique of modern organic chemistry at moderate cost, is particularly valuable for Indian laboratories which suffer from a shortage of funds. Experiments are described in great detail, aided by clear diagrams, photographs and Kodachrome reproductions. Typical of the sound practical advice in which the book abounds is the following: "Considerable time can be saved by cleaning each piece of equipment immediately after it has been used, for you will know then what type of contaminant is present and you will be able to remove it more easily than after it has dried and hardened".

Part I, consisting of 42 chapters, deals with experimental technique and the preparation of a representative series of organic compounds. Examples are given of enzymatic resolution, elution and paper chromatography, use of ultraviolet and infrared spectra, and cost calculation. In Part II, Mary Fieser has contributed a chapter on use of the literature, and the Fiesers together have listed in Chapter 50 the more important reagents which are useful for general purposes and for special applications in organic chemistry. Other chapters of Part II cover miscellaneous topics, such as reaction temperatures, evaporation, solvents, accessories for reactions, and glass blowing.

K. V.

Books Received

Blood Coagulation and Thrombosis—British Medical Bulletin, Vol. 11, No. 1 (1955). Pp. 1-82. Price 15 sh.

Hormones in Production—British Medical Bulletin, Vol. 11, No. 2. (The Medical Department, The British Council, 65, Davis Street, London, W. 1), 1955. Pp. 83-168. Price 15 sh.

Determination of Organic Structures by Physical Methods. Edited by E. A. Braude and F. C. Nachod. (Academic Press, Inc.), 1955. Pp. xiii + 810. Price \$15.00.

Annual Review of Biochemistry, Vol. 24. Edited by J. Murray Luck, Herbert S. Loring and Gordon Mackinney. (Annual Reviews, Inc., California, U.S.A.), 1955. Pp. xvi + 805. Price \$7.00.

The Ether and Its Vortices. By C. F. Kraft. (Published by the author, Route 2, Box 687, Anandale, Virginia), 1955. Pp. vii + 66.

Principles and Practice of Antibiotic Therapy. By Henry Welch in collaboration with sixteen clinicians. (Medical Encyclopaedia, Inc., Interscience), 1954. Pp. xix + 699. Price \$12.00.

Erythromycin. (Antibiotics Monograph No. 1). By Wallace E. Herrell. (Medical Encyclopaedia, Inc., Interscience Pub.), 1955. Pp. viii + 56. Price \$3.00.

Antibiotics Annual, 1954-55. Edited by Henry Welch and Felix Marti-Ibanez. (1955). Pp. ix + 1154. Price \$10.00.

Luminescence of Biological Systems. Edited by H. Johnson. (AAAS, Washington 5, D.C.), 1955. Pp. xi + 452. Price \$7.00.

Advances in Experimental Caries Research. Edited by Reidar F. Sognnaes. (AAAS, Washington 5, D.C.), 1955. Pp. ix + 236. Price \$6.75.

Antimetabolites and Cancer. (AAAS, Washington 5, D.C.), 1955. Pp. vi + 312. Price \$5.75.

SYMPOSIUM ON ARTIFICIAL RAIN*

A SYMPOSIUM on artificial rain was held under the joint auspices of the Council of Scientific and Industrial Research and the Indian Meteorological Department in February 1953 in New Delhi, and the proceedings have since been published.

Twenty papers were presented and discussed at the symposium. The main conclusions derivable from the discussions may be summarised as follows:

(1) The results of the experiments carried out so far on the subject have been generally inconclusive; neither complete failure of the methods employed nor the certainty of getting any substantial increase of rainfall by those methods have been demonstrated; (2) the most favourable meteorological conditions for the artificial induction of precipitation are to be sought in regions and during seasons where natural precipitation is most likely; (3) the methods so far employed, viz., seeding clouds of temperature below the freezing temperature with dry ice or silver iodide, and spraying clouds of temperature above the freezing temperature with water have not been effective in

augmenting precipitation in an area of very low rainfall or during dry periods in regions of normally moderate rainfall.

These tentative conclusions indicate the need for further studies and experiments on artificial modification of clouds and precipitation. There is, in fact, urgent necessity for properly designed and rigorously checked experiments being undertaken in regions where there is a possibility of success, and for proper methods being developed to evaluate the amount of precipitation resulting from such experiments. It is also essential that in all such experiments, the collaboration of the meteorological service is made available for ensuring the required reliability in the interpretation and assessment of the result.

The volume also contains as Appendix I abstracts of papers not published in full in the volume; Appendix II contains the recommendations made by the Atmospheric Research Committee to the CSIR in the light of the symposium. The Council has accepted the recommendations in principle, and has been considering the implementation of the proposal of forming a Rain Research Unit and a Cloud Physics Research Unit, to facilitate further advances in this important subject.

* *Symposium on Artificial Rain* (Published by the CSIR, New Delhi), 1955, pp. v + 148, Price not given.

SCIENCE NOTES AND NEWS

Early Occurrence of Red Rot in Bihar

S. L. Sharma and H. C. Jha, Central Sugarcane Research Station, Pusa, Bihar, observe that red rot lesions in sugarrane on mid-ribs of leaves just emerging and acervuli on the spindle were noticed as early as 14th April this year. In the beginning, the affected portion of leaf midrib become straw-coloured at several places. In the discoloured area there were dark grey or blackish blotches surrounded by a deep red margin. Spindles on pulling out, showed reddish pink spore masses which on culturing on oat meal agar gave typical red rot colony of 'D' strain. The shoots ultimately dried up and died. In the fields too, the disease has been noted early in May in Hasanpur (Darbhanga) and Riga (Muzaffarpur), in June in Lauriya, Narkatiaganj, and Bagaha (Champaran) in North Bihar.

Award of Research Degree

The Andhra University has awarded the D.Sc. Degree in Geology to Sri. M. Poornachandra Rao for his thesis entitled, "Some Aspects of Marine Geology in Certain Parts of Bay of Bengal".

The University of Bombay has awarded the Ph.D. Degree in Chemistry to Sri. P. R. J. Gangadharam for his thesis entitled "Studies on the Chemotherapy of Tuberculosis".

The Lucknow University has awarded the Ph.D. Degree in Geology to Shri C. G. K. Ramanujam for his thesis entitled "Fossil Woods from the Tertiary Rocks of South India".

The University of Poona has awarded the Ph.D. Degree in Agricultural Plant Pathology to Shri Veerendra Vijayshanker Bhatt for his thesis entitled, "Further Studies on Phytopathogenic Bacteria of India".

Dr. K. R. Surange

The International Organization of Palaeobotany is publishing a Report on World Palaeobotany with a board of regional editors to collect and forward reports on all books and papers published in their respective regions. Dr. Surange, Assistant Director and Officer-in-Charge, Birbal Sahni Institute of Palaeobotany, Lucknow, has been appointed as the Regional Editor for Asia. Dr. Surange has also been elected as a member of the International Committee for Palaeobotanical Nomenclature.

Zoological Society of India—Award of Bhalerao Memorial Medal

The Zoological Society of India will award the above medal in January 1956, in respect of contributions in helminthology, both pure and applied, by any research worker in India (irrespective of the year of publication).

Workers in helminthology are requested to send reprints of their contributions and three copies of a list of these reprints. The adjudication for the award will be made only on the basis of reprints submitted.

Reprints should be addressed to Shri M. A. Moghe, Department of Zoology, Poona University, Poona-7.

Memorial to Prof. H. K. Mookerjee

The Zoological Society has formed a Professor H. K. Mookerjee Memorial Committee with Professor S. N. Bose as President, to perpetuate the memory of Professor Himadri Kumar Mookerjee, former Head of the Department of Zoology, Calcutta University, and President of the Society. The Committee appeals to all friends, students and admirers of the late Professor Mookerjee to contribute liberally towards the fund for raising a suitable memorial. All contributions may kindly be sent to the Hon. Treasurer, The Zoological Society, 35, Ballygunge Circular Road, Calcutta-19.

International Symposium on Macromolecular Chemistry

The above symposium will be held under the auspices of the International Union of Pure and Applied Chemistry and the Weizmann Institute of Science, in Rehovot, Israel, on April 3-9, 1956.

The object of the symposium is to discuss the behaviour of polymers, biocolloids and polyelectrolytes in solution, but it is hoped that the symposium will also provide an opportunity for a general exchange of ideas, between polymer chemists and biophysicists on the biological implications of the physical chemistry of biocolloids and polyelectrolytes. Further particulars can be had from Prof. A. Katchalsky, Head of the Department of Polymers, Weizmann Institute of Science, Rehovot, Israel.

INSDOC Report, 1954-55

This third report, presenting the activities of the Indian National Scientific Documentation Centre, New Delhi-12, records continued efforts in organising and executing documentation service. The demands made on the Centre have been heavy, and have far exceeded the earlier anticipation. In the category of responsive documentation, INSDOC received 4,800 orders for services, comprising copies of 4,336 documents, translations of 411 scientific articles, and requests to conduct 53 literature searches. In 1953-54 the total orders received were 3,531. The increase recorded this year comes to 36%.

INSDOC entered the field of active documentation with the publication on June 1, 1954, of a semi-monthly, classified bibliographical journal entitled *INSDOC List of Current Scientific Literature*. The periodical furnishes advance information about published papers, and has been well received, both in India and abroad.

Chemical Extraction of Cane Sugar

The first successful plant for extracting sugar by continuous diffusion process has started operation at Fellsmore Sugar Producers Associations' Factory at Fellsmore, Fla. The installation is a pilot plant but its designers, National Cylinder Gas Co., have blueprints for plants capable of outputs of 150-1,500 tons a day.

On the figures published, the present crude method of extracting the juice by crushing the cane between rollers will not be competitive with diffusion, in which sliced cane is circulated with hot water and recycled juice in a tower. The effect is to render the cell walls permeable and dissolve out the sucrose by osmotic transfer. A juice extraction of 97% is guaranteed and may be as high as 99%, with a purity two or three points higher than for milling because more impurities are left in the exhausted cane. The chemical plant requires half the weight of steel of a mill of the same capacity, costs half as much, needs less than half the power and is operated by two men.

—*Chemical Engg.*, May 1955.

Aerial Blobs

In a recent paper in *Science*, F. Zwicky calls attention to some striking features of the stellar scintillations and excursions that are due to what may be termed aerial 'blobs'. Although many atmospheric disturbances refract, diffract, scatter or absorb light from distant celestial and terrestrial sources in an irregular manner, aerial blobs which are volumes of air of locally

altered density, temperature and water content possess remarkable optical properties. Blobs in combination with the mirrors or lenses of a telescope often bodily displace the images of stars or focus them in points in front or behind the regular focal surface.

Linear dimensions of aerial blobs have been observed ranging from millimetres to many metres. Blobs may be globular, lenticular, or cylindrical in shape, thus producing sharp point-like or line-like extra-focal images of stars. Often hundreds of blobs are quite regularly spaced and drift with the winds at various altitudes up to 50 km. or perhaps higher.

A most amazing feature of many aerial blobs is their durability and stability; some of them preserve their shapes for hours. The reasons for the durability of aerial blobs are not yet well known. It is suggested that their stability is related to the thermal, calorific and electric phenomena that govern and regulate the water content of the blobs.

New Alkaloids from *Rauwolfia*

Sandoz, Inc. of Basle, Switzerland, have reported the isolation of two additional alkaloids from *Rauwolfia canescens*. These are pseudo-yohimbine and canescine, the latter having pharmacological properties similar to those of reserpine. The methoxy group in position 11 of the reserpine molecule is absent in canescine but this does not seem to be necessary for the action of these compounds.

Rauinormine, an alkaloid isolated from a species of *Rauwolfia* not exploited commercially previously, has been isolated by the research group in S. B. Penick & Co. The alkaloid is believed to be identical with canescine (*Chem. Eng. News*, 1955, 33, 1076).

Fuels and Lubricants Laboratory

A new Fuels and Lubricants Testing Laboratory was recently inaugurated by Professor M. S. Thacker in the Internal Combustion Engineering Department of the Indian Institute of Science, Bangalore. Equipment for the new laboratory has been largely contributed by a number of German industrial firms. The setting up of the laboratory is the first step towards a more scientific approach to the problem of utilization of indigenous fuels in India.

ERRATA

Article on 'Structure of DL-Aspartic Acid' (1955, 24, 294), column 1; para 2; line 3: read internal for integral. In Table I, under z (row 6): read 0.049 for 0.094.

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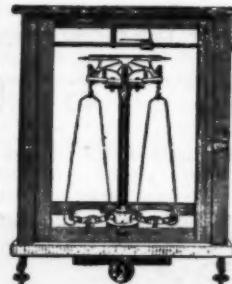
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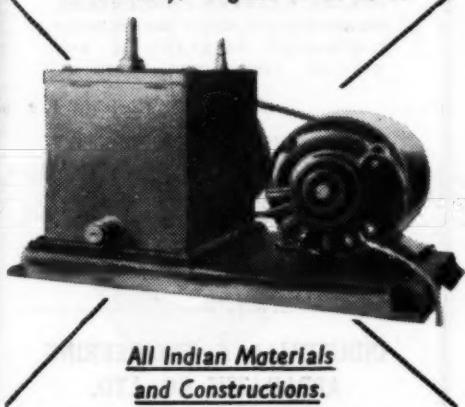
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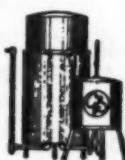
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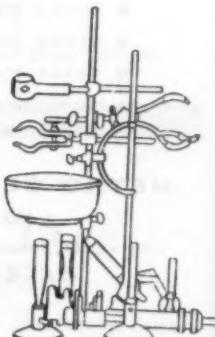
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